



The **CRUSHED STONE JOURNAL**

PUBLISHED QUARTERLY

In This Issue

■
The Role of Public Works

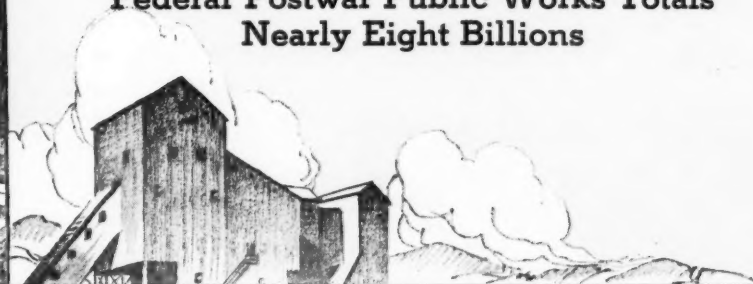
■
General Construction Equipment
Accidents

■
Stabilized Crushed-Rock Surfaces

■
Concrete Pavements Without Steel

■
Government Questionnaires and Reports

■
Federal Postwar Public Works Totals
Nearly Eight Billions



June • 1943

Official Publication
NATIONAL CRUSHED STONE ASSOCIATION



Technical Publications
of the
National Crushed Stone Association, Inc.



BULLETIN No. 1

The Bulking of Sand and Its Effect on Concrete

BULLETIN No. 2

Low Cost Improvement of Earth Roads with Crushed Stone

BULLETIN No. 3

The Water-Ratio Specification for Concrete and Its Limitations

BULLETIN No. 4

"Retreading" Our Highways

BULLETIN No. 5

**Reprint of "Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey"
with Discussion**

BULLETIN No. 6

The Bituminous Macadam Pavement

BULLETIN No. 7

Investigations in the Proportioning of Concrete for Highways

BULLETIN No. 8

**The Effect of Transportation Methods and Costs on the Crushed Stone, Sand and Gravel,
and Slag Industries**

BULLETIN No. 9

Tests for the Traffic Durability of Bituminous Pavements

BULLETIN No. 10

Stone Sand

BULLETIN No. 11

A Method for Proportioning Concrete for Compressive Strength, Durability and Workability

Single copies of the above bulletins are available upon request.

**Manual of Uniform Cost Accounting Principles and Procedure for the Crushed Stone
Industry (\$2.00 per copy)**

The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION



1735 14th St., N. W.
Washington, D. C.

OFFICERS

WM. M. ANDREWS, President
WM. E. HILLIARD, Treasurer
J. R. BOYD, Administrative Director
A. T. GOLDBECK, Engineering Director

REGIONAL VICE PRESIDENTS

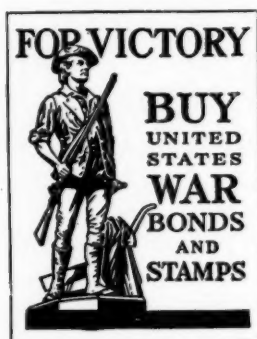
A. J. CAVIA W. T. RAGLAND
T. C. COOKE W. C. SPARKS
F. O. EARNSHAW A. J. WILSON
PAUL M. NAUMAN W. F. WISE

EXECUTIVE COMMITTEE

WM. M. ANDREWS, Chairman
OTHO M. GRAVES RUSSELL RAREY
E. J. KRAUSE J. A. RIGG
PAUL M. NAUMAN STIRLING TOMKINS
A. L. WORTHEN

Contents

	Page
The Role of Public Works	
—Col. Willard T. Chevalier	3
General Construction Equipment Accidents	9
Stabilized Crushed-Rock Surfaces	
—J. E. Herzog	17
Concrete Pavements Without Steel	
—L. E. Andrews	19
Flight Strips Keep 'Em Flying	22
Government Questionnaires and Reports	
—Stuart A. Rice	23
Federal Postwar Public Works Totals	
Nearly Eight Billions	28



Double-Barrelled Security

If you are hard-headed
about loaning money,
here's Security enough
for you:

Bonds that grow with
certainty, guaranteed by
the soundest firm in the
world Bonds that
daily guarantee your
personal safety and
happiness.

Can You Afford NOT to Make this Investment Today?

Let's Give Tyranny



BOTH BARRELS!



THE CRUSHED STONE JOURNAL

WASHINGTON, D. C.

Vol. XVIII No. 2

PUBLISHED QUARTERLY

JUNE, 1943

The Role of Public Works¹

By COLONEL WILLARD T. CHEVALIER

Publisher, Business Week, New York City

Public Works Defined

ANY discussion of public works in postwar planning or, for that matter, in any capacity, calls for a definition of the term. Just what are we talking about?

For my purpose here today, public works are those fixed facilities that are required to meet the needs of community life and that are built and maintained by the community out of public funds rather than by private enterprise.

Some of them are built by the federal governments flood control and irrigation works, river regulation and federal buildings. Some are built by the states or their subdivisions: highways, penitentiaries, and drainage works. Most of them are built by the cities, towns, and villages: waterworks, sewerage systems, school buildings, and street pavements. Some public works are built jointly by two or more governmental agencies, others are built by a community but operated by private enterprise.

The essential feature of public works is that the fixed facilities be provided by some public agency using public funds.

Such public works normally fall into two categories (1) those that serve the public directly, like a sewerage system, and (2) those that serve less directly by providing an opportunity for private enterprise, like the highways.

To understand the importance of the first type, we must remember that the vaunted American standard of living does not rest exclusively on our gadgets—our automobiles, radios, and electric refrigerators.

• Of vital interest to crushed stone producers are the various programs for postwar construction, particularly with reference to highway construction. Postwar planning should not be based on the expectation of a depression but on the serious economic need for highway construction. In the following analysis Colonel Chevalier gives a most interesting and valuable discussion of this highly important subject.

It requires certain services as well as gadgets, services that are provided through a variety of community agencies.

Among these services we find items so fundamental as ample and safe water-supplies, sanitary sewage disposal, public recreation facilities. They include general education, convenient distribution of food, reasonable conservation of health—to note but a few that require fixed facilities for their maintenance. And such public works are just as vital to the American standard of living as those great factories that turn out our washing-machines, vacuum cleaners, and motion-pictures.

The second class of public works that I have mentioned includes those facilities provided by public funds which become effective only after private enterprise has turned them to use.

The automotive industry, for example, owes its amazing growth to the construction and maintenance of improved public highways. And when I speak of the automotive industry I mean not merely the manufacturing of the cars, of the gasoline that drives them, and of the tires on which they roll. I include also the many varied services, such as filling stations, garages, insurance, tourist-camps and roadside stands, that are inseparable from motor transport and likewise dependent for their existence on the public highways.

¹ Presented before the luncheon on "Democracy and Jobs" during the 31st Annual Meeting of the Chamber of Commerce of the United States, held—New York City, April 29, 1943.

Then, too, large sections of agriculture and its tributary industries are able to exist only because of public installations to control floods, irrigate waste lands, and conserve the soil and the forests.

Public works of this type contribute materially to the greater productivity and the profitable expansion of business activity in many fields. There can be no question of their essential place in an American economy of free, competitive enterprise.

When I confine the term "public works" to such useful facilities, I exclude what we know as "pyramid building"—that is, the spending of public funds on projects of dubious utility, primarily for the purpose of making jobs for those unable to find productive employment. Such undertakings are in fact social devices to avert widespread distress and unrest. They should be considered as such and not misnamed, to the detriment of legitimate public works. Any confusion between social measures, designed to mitigate the evils of unemployment, and economic measures, directed toward maintaining productive employment, obstructs a sound approach to the problems of postwar adjustment.

The Essential Place of Public Works in Our Economy

Another reason for consistently observing this distinction will suggest itself to those who see clearly the essential place of public works in our economy but who cherish no yearnings to "make America over." I refer, of course, to the importance of curbing the tendency to lump public works indiscriminately with the various social and political devices that are designed to help the "make-America-over" boys toward their objectives.

For example, I quote the following passage from the recent report on "Post-war Plan and Program" by the National Resources Planning Board:

"Public works, social security, and like programs and activities give reality to the maintenance of adequate purchasing power, the securing of full employment and the optimum degree of private business activity . . ."

If that means what it seems to mean, it is a challenging concept. "Securing the optimum degree of private business activity" implies a regulation of the economy, so that we shall have that degree of private business activity which some one or some group or some agency considers the most desirable or advantageous. Now, "Social security and like programs and activities"—whatever those may be—can be manipulated to serve such a purpose, but I see no possible excuse for classing public works along with

them. I can, however, see that the public works label might be plastered on such activities. And that is what we should avoid. I recall an old proverb about giving a dog a bad name and then hanging him for it. Legitimate public works are too important a function in American life to have them saddled with an onus that might lead to their exploitation on the one hand or their starvation on the other. Let us think of them always for what they actually are.

Lest my quotation of one passage from the Resources Board's report lead to an unfair misapprehension, I hasten to quote another passage that states admirably the point I am trying to make. In discussing a postwar program of public works, the report says that

"Our general policy for a postwar public construction program must be such as to assure that projects will always be so selected as to provide the maximum service benefits. Work should not be undertaken just because it is work and for no other reason. Rather, our effort always should be to select and construct those projects which will provide the maximum of public service for the minimum outlay of labor, materials, equipment, and public funds." That is very soundly put.

Public Works and Postwar Planning

With this background and these distinctions in mind, it is in order to ask why this subject of public works comes up at all in connection with postwar planning. Part of the answer is suggested, I think, by the full page headlines in which one New York newspaper announced the report of the National Resources Planning Board, from which I have quoted. In large letters, its front page declared simply, "Jobs for All." Which is a reminder that a substantial part of our people think of our postwar problem as being essentially one of finding or making jobs for a lot of people. The rest of the answer is found, then, in the widely-promoted notion that public works are a sovereign recipe for making jobs. The argument goes something like this: The Postwar problem is one of making jobs. Public works can be used to make jobs. Therefore, public works should have a part in our postwar planning.

But before we accept that reasoning at its face value, we should take a good look at the problem and at the record.

The basic concept of public works as an economic and social instrument is as old as history. The Egyptians, the Romans, and other peoples of antiquity dealt with economic collapse and social unrest by

putting their people to work on public structures of greater or less utility. But in the mind of the American business man, public works spending as an instrument of governmental policy is tied up closely with the depression of the thirties. That's when he first had to think about it, appraise it, and pay for it. That's when it became a subject of more academic interest to him.

But so much has happened since these doleful days that many of us have forgotten why and how we came to invoke public works as a remedy for our ills. As one of those who were privileged to observe closely the development of the public works program, may I review the story briefly.

Two different, and at times divergent and opposed motives animated those who backed that program. One of these was to make jobs—to make them in any possible way. Whether it be by leaf-raking, boondoggling, work-relief, public-works or whatever you please, the purpose was to get the unemployed on the public payrolls in some capacity, even though at a mere subsistence wage. That phase of the public-works program we might call “public works for relief.” Its objective was social. Its ultimate instrument was the WPA.

But there was another body of support for the program that was interested primarily in its “pump-priming” possibilities. The hope of this group was that a large program of useful public construction, financed largely by federal borrowings, would substitute for the lack of private investment and thereby stimulate a dormant economy into new life. That program we might call “public works for recovery.” Its objective was economic. Its ultimate instrument was the PWA.

Here, today, any discussion as to the merit or achievements of these programs would not be relevant. Let it be said only that this experience with public works during the depression explains in large measure why so many of our people have lost their sense of the fine distinction between public works as an essential adjunct to a high standard of community life and public works as an instrument invoked by government to influence economic and social trends.

Now let us see how the characteristics of that instrument might fit out postwar problems. When we do that we are impressed at once by the fact that postwar conditions—subject to reservations I shall suggest farther on—bear little resemblance to those of the early thirties, when we first invoked our “Public works” policy.

The postwar problem surely is not one of pump-

priming. During the last few years and probably for another year at least, we shall have carried on, through the war effort, a pump-priming operation that beggars the most fantastic aspirations of those who complained that our program of the thirties was not more successful only because there wasn't enough of it. Today our pump is primed to overflowing, so far as public spending and deficit financing can contribute to that end. Now we are struggling desperately to siphon off some of that overflow before we all are drowned in a torrent of surplus purchasing power.

Neither is our postwar problem one of unemployment, such as prevailed in the thirties. For the dominant characteristic of the postwar period will be a vast volume of deferred demand for goods and services that will have accumulated during the war, and the vast need for human services the world over to make good the material destruction of the war.

During the thirties we were laid low by deflation; our constant concern was to achieve a “reflation” as we were schooled to term a counter-inflation. We craved a “shot in the arm” that would put us on our feet. Today we are doped to the eyes with inflation, and the chief concern of our economic doctors is to quiet us down and get us to stay in bed.

I referred a while back to a reservation I must enter against the proposition that postwar conditions will bear little resemblance to those of the pre-war depression. That reservation is this: provided, however, that we can contrive to avert the threat of disastrous inflation—during or after the war.

Vast streams of purchasing power now are pouring into the pockets of our people so that our greatest domestic hazard is the pressure of those funds, damned up as they are by the closing of thousands of their normal outlets.

There, it seems to me, is the evil genius of our postwar set up. For if we succumb to that threat we shall find ourselves at some point in the postwar period exactly where we were in 1930 and 1931 and 1932. Then it might be in order to talk of public works as a stimulant, if, indeed, we are not already beyond the power of any revival.

But if we manage to avert that threat, we shall enter the postwar period with a substantial part of this purchasing power clamoring for the goods that people will for so long have gone without. So our problem then will not be to create purchasing power or devise “synthetic” jobs.

It will be the reverse of our depression problem. We shall face the double task of converting our capi-

tal facilities from wartime to civilian production and of getting into production as quickly as possible on the goods we shall need to meet the pent-up demands of the people.

All this does not mean that we should not now be organizing our postwar effort in terms of jobs. Those now planning for the postwar period must do so in terms of the jobs that will be available to those who will be released from military service and to the great bulk of those now engaged in war production. But because we measure our task in terms of employment, it does not follow that our problem will be one of unemployment.

Our task, in fact, will be that of bringing together, as quickly and as efficiently as possible, ample manpower, ample demand, and ample purchasing power. Our task will be to get as quickly as possible into full production. If we can do that, full employment will take care of itself.

Major Postwar Problem is Effective Use of Manpower

Briefly stated, then, our major postwar problem is to swing our manpower into the task of rebuilding and reconverting our productive facilities to meet the pent-up civilian desires of the people. This combination of demand for both capital and consumer goods should, with some bold and intelligent planning, enable us to achieve the full production of which we are capable, with full employment, not for just a year or two, but on a more enduring basis.

But the key to this program will be found in the use of our manpower on productive jobs—jobs that will add to the actual wealth of the American people—not merely on jobs that have little meaning other than the addition of names to payrolls.

In such a program both private and public enterprise must have a place. But the major responsibility of government will not be, as some seem to think, to stimulate a prostrate or faltering economy. The present symptoms do not indicate a need for deficit spending on public works but rather the creation of a climate that will foster sustained expansion of business enterprise in the production of both consumer and capital goods.

Here is not the place to discuss the measures that might be invoked to create such a climate. They must be the subject of extended study and educational effort on business men as well as on governmental officials, for I suspect that you will find as many conflicting views amongst the business men themselves as between the business men and the offi-

cials. Right here my only purpose is to emphasize that the most productive role of government in the postwar economy will be that of regulator and umpire rather than that of stimulator and substitute.

This means that postwar public works construction, like all other postwar economic activity, should be on the basis of utility, "to provide the maximum of public service for the minimum outlay of labor, materials, equipment, and public funds," as the National Resources Planning Board has put it. "The postwar program that we shall undertake," to quote the Board once again, "will be in reality the postwar version of our regular public works program, rather than a special purpose program set up parallel to a program of regular activities."

To that statement I would add one further specification: that in carrying out such a program, we adhere to the normal and well-established system of competitive contracts, thereby making full use of the organization and resources of the construction industry. In the interest of public economy we should resort to direct government employment of day labor for public works construction only to meet exceptional conditions under which the contract system clearly cannot be applied effectively.

Such a policy, if we adhere to it, will insure the maximum contribution that a public works program can make toward postwar readjustments of the economy as a whole.

A Postwar Public Works Budget

No rigid and detailed postwar public works budget can be compiled at this time, but measures already in hand to that end should be continued from now on. A rough estimate of a rational total expenditure may be made, however, based on estimates of the national production that would be necessary to provide full employment.

Using as a base an estimated \$135,000,000,000 of total national income, we may estimate about \$16,500,000,000 of total construction activity both public and private. Of this total, about 30 per cent, or about \$5,500,000,000 would represent a reasonable share for public construction. This would be about \$40 per capita. From 1915 to 1929 expenditures for public works construction and maintenance increased from \$9.89 to \$26.55 per capita, or about 170 per cent. A continuation of that rate of increase during the 15 years from 1929 to 1944 would indicate a volume now in the planning stage of something like \$70 per capita. The fact that we cannot conservatively plan for more than \$40 per capita in a postwar program suggests

that from 1929 on our living standards did not expand as rapidly as they did in the preceding 15-year period.

Public Construction Must Aid Peacetime Production

Neither can we hope to embark on this conservative program immediately upon the conclusion of the war. As a first principle, may I quote again from the National Resources Planning Board's report: "Our postwar public construction program must be so planned that it will aid and completely avoid hampering the rapid reestablishment of peacetime production."

We must be on our guard on two counts. First, as I have said, the immediate need after the war will be for consumer goods to balance an already excessive purchasing power. If we were to concentrate at the outset on public construction at the expense of consumer goods production, we should merely be adding to that purchasing power without increasing the volume of goods and services available in the markets. The net effect of this would be to add to the inflation pressure that would already be inherent in the immediate postwar situation.

Moreover, we must time the planning of public construction to serve effectively the tasks of industrial reconversion and private building. After all, we are now planning to reconvert from a huge "public works program"—if you please to designate the war as such—back to an economy of private enterprise. Today all private enterprise must be subordinated to the public effort to win the war. By the same token, we should make sure that in reconversion our public enterprise be subordinated to the effort of private enterprise to win the peace.

Such a policy will influence the shape and timing of many projects. I assume, of course, that deferred essential services such as waterworks, sewerage, pavements, and the like will be put promptly into hand. I assume also that the reconstruction of our highway system to meet modern traffic standards, interrupted by the war, will be resumed and accelerated both to compensate for deferred maintenance and to meet even higher postwar requirements.

Need for New Forms of Public Facility

We shall be faced also with the need for certain new forms of public facility. The postwar expansion of civil aviation will call for more public construction of air ports than might even have been contemplated before the war. And if we are to undertake, under either public or private auspices, the mass pro-

duction of small homes and the elimination of slum areas, we probably shall find it necessary to build new or to rehabilitate the waterworks, sewerage, and street facilities required to serve them.

Whatever industrial expansion we may contemplate under private enterprise to help realize higher living standards will have its counterpart in an expansion of public facilities designed either to service the industrial expansion or to provide basic facilities that are prerequisite to it.

If we regard our public works in this light, i.e. as essential service facilities geared to the rest of our economic activities, we shall not go astray in planning their place in a postwar program. For public works, soundly conceived, built, and administered, are an essential element of the physical plant that constitutes the capital of the American people, that provides the material basis for the human welfare of our people as well as for their agricultural and industrial progress.

Should Be Decentralized

One more point must be made with respect to public works planning. By far the largest part of public works activity is carried on by the municipalities rather than by the federal and state governments. This fact frequently is overlooked. Whatever collaboration the federal government may offer in overall planning, whatever financial help it may make available in the form of loans or grants, the great bulk of the public works is made up of local projects to serve cities, towns, and villages.

Public works planning, therefore, should be decentralized. No central agency, trying to blueprint a master plan, can foresee and provide wisely to meet the needs of thousands of individual communities, ranging in size from great industrial cities to modest county seats. That is particularly true during the difficult period of reconversion.

Already the Council of State Governments has taken this job in hand. Many municipal governments have blueprinted sizeable public works projects. But it is desirable that much state and municipal planning should be done in close cooperation with local industries and business activities so as to coordinate with them in the interest of timing for most effective handling of reemployment during the process of reconversion.

Now is a good time to do all this. War construction has passed its peak. Civil engineers and architects now become available in increasing numbers. Their services will be needed especially by those

committees which have experienced large population growth incident to the advent of new industries and which already are faced by the problems of inadequate services.

Let me suggest here one more phase of this public works problem. Thus far, I have discussed it as a domestic matter, touching only the needs of the American people. But it looks now as though we, as a nation, may emerge from this war in a new relationship to the rest of the world—one that will involve responsibilities and opportunities outside of our national boundaries.

In that capacity we may be called upon to take a substantial part in the rehabilitation of old countries that have been devastated and in the original building up of some underdeveloped regions. Out of the war may come some form of international public works program to those ends.

Such a task naturally would not be our exclusive responsibility or opportunity. But for a time, at least, we may have to provide most of the necessary technical direction and supply much of the machinery and materials that will be necessary. That responsibility may well rank equal in importance to that of participation in the political and economic rehabilitation of a devastated and distracted world. Enlightened self interest will leave us no choice but to take our part in both.

Business Men Should Participate

In conclusion, may I suggest that now, while business men are assuming their share in the planning for post-victory full-production-employment, they do not dismiss public works planning as being outside their jurisdiction. They are citizens of their communities. The public works of their communities should be planned and administered wisely if the funds to be spent on them are to return full value to the people. These public investments of the people's capital will call for the same kind of examination, appraisal, and planning as do their investments in private capital. They call for the business man's interest, guidance, and continuing participation.

There can be little doubt that government—national, state, and local—will, in the post-war America, exert a greater influence than ever before over the lives of the people and their business affairs. The men of business will be wise then—in their own interest as well as in that of the people they serve—to participate more closely than ever before in the many agencies of government. This goes not only for those regulatory agencies with

which they must work as a matter of self-preservation, but also with those constructive agencies which deal with the social and economic sides of community life.

Public works offer a national field for such a participation, and post-war planning offers an approach that is timely and fitting. Wherever business men now are taking an active part in post-war planning, I suggest that they get together now with municipal and state bodies that are working on postwar public works projects.

Helpful participation now in the planning and administration of legitimate public works would provide a safeguard against the perversion of a perfectly legitimate community function to purposes that are not in harmony with the traditional American concepts of public and private enterprise.

Stirling Tomkins Joins Staff of American Red Cross



HIS many friends throughout the crushed stone industry will be interested in knowing that Stirling Tomkins, President of the New York Trap Rock Corporation, and for many years a member of the Board of Directors and Executive Committee of the National Crushed Stone Association, has arrived safely in North

Africa to assume his duties as assistant to American Red Cross Delegate William Stevenson. As second in command, Mr. Tomkins, who volunteered his services, will aid in direction of the club, recreation, hospital and welfare programs carried on by the Red Cross for the troops in North Africa.

In the belief that he would probably be gone for an extended period, Mr. Tomkins felt it necessary to tender his resignation from the Board of Directors and from the Executive Committee of the Association. Mr. Tomkins has rendered outstanding service to the Association since his affiliation therewith and our debt to him is especially great for the wise counsel which he has constantly rendered in the administration of Association affairs. He will be deeply missed, but our loss will certainly be the gain of the American Red Cross for in him they have obtained a highly capable executive, particularly well qualified for the character of work which will be under his supervision. We wish him the best of success and a speedy and safe return.

General Construction Equipment Accidents

By the Safety and Accident Prevention Branch, Construction Division, U. S. Corps of Engineers

ACCIDENTS resulting from the operation and use of mechanical equipment in 1942 comprised 30% of the total accidents reported and produced 42% of the days lost from all accidents. A total of 36,338 lost time injuries were reported, of which 10,964 involved mechanical equipment. Of the 4,944,517 days lost from all injuries, 2,072,196 were charged to mechanical equipment accidents. It is obvious that a

- The crushed stone industry can and should make a real contribution to the war effort by reducing the number and severity of accidents which take place in quarry operations. Improper use of mechanical equipment is a major cause of accidents. Much of the equipment covered in the following analysis is used in the crushed stone industry, which should make this study of great value to quarry operators.

TABLE I

Type of Equipment Involved in Accidents	Lost Time	Injuries
General Construction Equipment ----	52%	25%
Tractors and Bulldozers	11	—
Cranes, Derricks, etc.	11	—
RR Locomotives and Cars	12	—
Draglines, Shovels, Graders, etc.	9	—
Mixers, Crushers, Batch Plants, etc.	9	—
Motor Vehicles, Trucks, etc.	34	22
Hand Tools	5	28
Portable Power Tools	3	7
Shop Machinery	2	4
Mechanical Power Transmission	2	4
Pressure Vessels and Boilers	1	3
Dredges and Barges	1	*
Welding Machines	*	2
Wheelbarrows and Hand Trucks	*	5
	100%	100%

* Less than ½%.

† A similar study is in process for motor vehicle accidents.

substantial improvement in severity can be effected by a reduction in the number of equipment accidents.

The analysis also indicated tremendous financial losses due to property damage, repair of equipment, and delay and/or loss of use of equipment taken out of service.

Significant aspects of the analysis are the following:

1. Only 30% of all injuries involved mechanical equipment, but they produced 42% of the lost time from all accidents, and half the fatalities.

2. More than half of all lost time from injuries in equipment accidents involved the use of cranes, draglines, tractors, and similar general construction equipment, i.e., 25% of the equipment accidents produced 52% of all the lost time in those injuries.

3. Motor vehicles were involved in 22% of the accidents and produced 34% of the days lost in all injuries involving equipment.

4. In contrast, hand tools comprised 29% of the equipment accidents, but resulted in only 5% of the days lost from those accidents.

5. Miscellaneous equipment was involved in the remaining 25% of the accidents, but produced only 14% of the total days lost.

General Construction Equipment Accidents

In view of the fact that general construction equipment was involved in only 25% of the total mechanical equipment accidents but produced 52% of all the lost time from those cases, this detailed study is confined to the accidents involving tractors, bulldozers, cranes, draglines, railroad locomotives and cars, power shovels, graders, concrete mixers, and similar equipment.

The great majority of the accidents were caused by inadequate maintenance of equipment, insufficient instruction in safe practices, or lack of insistence on their observance. Unsafe practices were factors in 80% of all injuries. The responsibility for correcting unsafe practices rests primarily with supervisors. Until accident prevention is given consideration equal to production by all supervisors, serious injuries, delays, and damage to equipment from the same causes will continue to occur.

Concentration on major accident sources and causes offers the biggest opportunity for reducing serious injuries with the available time and money. The most frequent cause of the general equipment accidents was failure to watch, warn or signal workers likely to be endangered in backing, turning, swinging buckets, lowering mixer skips, and making similar movements. The elimination of this cause should receive most attention. Eight combinations of unsafe practices and conditions caused 75% of all injuries. Supervisors can, therefore, utilize the time available for accident prevention work most effectively by devoting the largest share to correcting these hazardous practices and conditions.

The eight predominant unsafe practices and conditions are:

1. Backing and turning machines, swinging booms, lowering buckets, etc., without looking, warning, or signaling.
2. Getting on or off equipment unsafely, unauthorized riding, etc.



THE OPERATOR DROPPED THE BUCKET WITHOUT WARNING OR A SIGNAL—ONE MAN KILLED AND OTHERS INJURED.

3. Defective—timing, brakes, clutches, cables, etc.
4. Working or walking under skips, buckets, loads.
5. Failing to retard spark, grip handle correctly, stand correctly, etc., in cranking.
6. Oiling, adjusting, repairing, etc., without stopping machines.
7. Unguarded and inadequately guarded fans, gears, etc.
8. Insecure grip, too heavy load, lifting with back, etc., in handling by hand.

(The complete list of causes and conditions is shown on Table II on page 16.)

The important fact about each of these accident factors is as follows:

1. *Backing and turning machines, swinging booms, lowering buckets, etc., without looking, warning, or signaling.* Operating equipment without warning, signaling, or making sure workers were in the clear figured in one of five accidents. This unsafe practice was an outstanding factor in accidents involving every type of heavy construction equipment, but was especially frequent in accidents involving switching railroad cars and operating concrete mixers. The average time charge per case, excluding fatalities, was 80 days.

Reports indicated a general lack of responsibility and procedures for controlling movements. Devices or means for warning workers were seldom provided. Signalmen were not posted, instructions about safe procedures were not given, and existing rules were not enforced until after accidents happened.

A typical accident occurred when a tractor operator started up without warning. A man who was working on the side of the machine suffered a crushed and mangled foot. In another case, a worker was requested by an operator to make a coupling and, as the man stepped between the machines, the operator



NO PLACE TO PASS—A SHORT CUT TO THE CEMETERY.

backed up without waiting for a signal. The worker received a crushing injury. In a third type of frequent accident a worker turned his back to the crane and bent over to arrange some pipe for the next lift.

The operator swung the hook toward the pile and the hook hit the man a lethal blow on the head. After this accident a gong was installed to signal all movements of the crane.

When hand signals were required, operators frequently disregarded the requirement. Such violations of instructions were not tolerated by some supervisors who discharged their operators for making a lift before the riggers gave the signal.

Repairmen and oilers were often injured because the operator started the equipment before the men completed their work and left the machine. There was no indication that maintenance men were provided with warning tags or other devices to place on starting apparatus to prevent unexpected starting.

Signals and instructions were often confused. When several employees were working together, one was not specifically designated to give all signals. Verbal instructions were not repeated. A repairman had both legs fractured due to a combination of these causes. He went under a machine to make an inspection; the operator was given incorrect instructions by an unauthorized worker, backed up, and ran over the repairman.

The extremely dangerous practice of going under equipment and in other dangerous places without

station signalmen at congested or dangerous locations. Six men were killed in an accident at a railroad crossing which did not have this protection. Other bad accidents involving restricted operators' vision could have been prevented by signalmen.



GET IN THE CLEAR—OUT OF SEAT WHILE LOADING.



A WORKER WAS CRUSHED IN THIS WAY. HE FAILED TO WARN THE OPERATOR AGAINST MOVING THE MACHINE.

notifying the operator, or taking other precautions, was the cause of several deaths. An oiler attempted to grease the track of a crane between swings and was crushed.

Reports frequently ascribed accidents to failure to

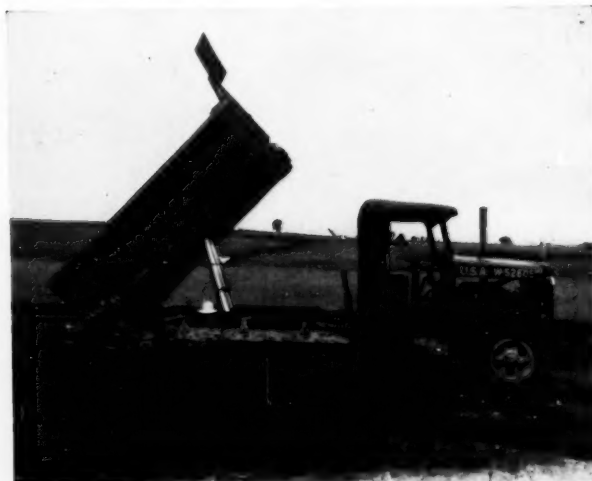
These men, however, should be carefully selected and instructed, because they also were occasionally injured.

2. *Getting on or off equipment unsafely, unauthorized riding, etc.* Slipping and falling in getting on and off standing or moving equipment resulted in one-eighth of all injuries. They varied in severity from strains to deaths. The worst accidents happened in getting on and off moving tractors, caterpillars, bulldozers, and railroad cars. Serious injuries were sufficiently numerous to justify the strict rule that only designated employees be permitted to ride on mobile equipment. Unauthorized riding on railroad cars frequently resulted in a fatality and strenuous efforts should be made to stop the practice.

Most injuries, however, happened in getting on and off stationary equipment. Jumping off was one

of the worst practices. One man who jumped from a standing railroad car sprained both ankles. Another worker failed to use the ladder, fell, and fractured his spine.

While muddy shoes and surfaces caused some bad strains and sprains in getting on and off standing



ACCIDENTAL RELEASE OF THE HOIST LEVER RESULTED IN THE DEATH OF A WORKER WHO WAS LEANING OVER THE FRAME GREASING THE EQUIPMENT.

caterpillars and tractors, most of the injuries occurred in good weather. Feet slipped on rough and frozen ground, rocks, and even pebbles in getting on equipment; in shifting position to get off, the smooth and uneven surfaces of the tracks caused slipping.

3. *Defective—timing, brakes, clutches, cables, etc.* Inadequate maintenance caused 10% of the accidents, according to reports. However, it is likely that the proportion is larger. More cranking accidents, for example, involved backfires than were specifically ascribed to defects in timing and starting mechanisms. The parts which especially require close inspection and better maintenance are brakes, cables, timing, and starting.

The worst injuries were due to defective brakes and worn cables. In many cases, they resulted in costly delays and property damage. In one bad accident due to faulty brakes, a worker was struck by a load and sustained a head concussion, broken ribs, chest injuries, and a broken leg. Other parts which were involved in accidents, and which should not be overlooked in making inspections, were clutches, clamps, hooks, and similar devices.

4. *Working or walking under skips, buckets, loads.*

Training workers to keep in the clear in walking or working near moving tractors, cranes, and similar equipment is necessary to eliminate the fourth of the major causes of heavy equipment accidents. Injuries due to failure to keep in the clear were far more numerous in hooking and releasing loads than in doing other jobs. The men failed to step back a sufficient distance while loads were raised and to stay back until they were lowered.

A typical accident happened in handling a lift of steel. The crane operator was lowering a load and before it came to rest, a worker took hold of the sling and the steel landed on his legs and feet. The employee also took a chance on having his hand or fingers crushed because loose, suspended loads sometimes shift. If a hook or board is not available for holding a sling in place in hitching loads, placing the flat of the hand against the sling is safest.

A number of serious accidents prove that the extra effort to get in the clear in working on elevations or in close quarters near swinging loads, buckets, and booms is worth the trouble. One accident which resulted in a fractured spine illustrates this fact. A tank was swung into position over its support on which a worker was standing, knocking him to the ground. Getting into the clear was inconvenient, so he took a chance.

A narrow opening between a revolving platform of a dragline, shovel, or crane and a heavy pile of steel, railroad car, or bank, was another hazardous location which trapped and killed workers who tried to squeeze through it. They took a short cut instead of walking around the machine the other way. Other injured men had ample working room around moving tractors, trenching machines, and similar equipment but failed to keep clear. A switchman who attempted to cross tracks just ahead of moving cars was struck and killed. A laborer was shoveling dirt too close behind a trenching machine; his shovel caught in the bucket line and jerked him into the machine.

Employees did not recognize the dangers of loose railroad ties, planks, and other heavy materials in the paths of moving equipment. When such materials were struck on the ends by the wheels of moving equipment, they flew and hit nearby workers. One man stood a few feet from a tie. The tie was struck by a caterpillar and hit the worker in the stomach.

Workers should also be taught to keep away after hitching or hooking chains and cables onto logs, stumps, and machines. When loads are pulled,

cables sometimes slip, hooks pull out, or logs catch and swing and nearby workers are struck. A laborer was badly injured and a tractor damaged in one of many accidents which occurred in this way. The man walked too close to a log towed by a tractor. The log, which was in addition hitched too close to the machine, caught against a rock and flew into the air. One end hit the machine and the other end hit a worker.

5. *Failing to retard spark, grip handle correctly, stand correctly, etc., in cranking.* Unsafe practices in cranking motors ranked fifth in the list of causes of general construction equipment accidents. Cranking is the largest single source of injuries in the operations of tractors and caterpillars. Accidents were due to failure to retard the spark, grip the handle with the thumb along the forefinger, stand correctly, and other unsafe procedures. One-half of the injured workers sustained fractured wrists and arms.

6. *Oiling, adjusting, repairing, etc., without stopping machines.* Working on or near moving parts of machinery is one of the principal unsafe practices causing permanent disabilities in most industries. This practice is sixth among the causes of accidents in operating general construction equipment. Injuries were exceptionally numerous in operating concrete mixers. Most of the remaining accidents occurred in oiling and repairing draglines, power shovels, and cranes. The average lost time per injury was large—241 days, excluding fatalities.

The most hazardous moving parts were cables, according to the reports. Riggers, oilers, operators, and repairmen were caught while freeing, adjusting, and repairing cables near sheaves and pulleys. The men took hold of the cables just ahead of the sheaves and their hands were jerked into them. In some cases the drums were turning too fast and the guiding was done with the hands instead of a bar. Slipping, partly due to insecure footing, sometimes preceded such accidents. In other accidents involving slipping, the feet were caught between revolving drums and frames. Gloves and loose clothing contributed to a number of cases. One-third of all accidents in working on moving parts involved cables, pulleys, and sheaves.

The other outstanding source was moving gears on cranes, shovels, and draglines. Oilers were frequently injured because they attempted to grease up without stopping the machinery. Several employees were crushed to death in trying to apply grease to tracks between swings of dragline plat-

forms. Gloves, loose clothing, and rags were also factors.

Other serious injuries occurred in cleaning conveyors, oiling and cleaning around motor fans, and cleaning and working around the skips and blades of mixers without first stopping them.



THIS SAFE METHOD OF SHORING THE BODY WOULD HAVE SAVED A LIFE.

7. *Unguarded and inadequately guarded fans, gears etc.* Inadequate guarding caused 6% of the injuries and was seventh in importance among the causes of general equipment accidents. Most of the injuries were due to unguarded gears on power shovels, mixers, and cranes.

Other unguarded parts of machinery were:

- Motor fans.
- Platforms on crushers and mixers, etc.
- Sprockets and chains.
- Belts and pulleys.

Some bad injuries were due to the failure of mechanics to replace guards and inspection plates after repairs.

8. *Insecure grip, too heavy load, lifting with back, etc., in handling by hand.* While injuries due to unsafe handling of materials and machine parts were generally less serious than those resulting from other unsafe operating practices, they were a substantial proportion of the total. Hernias and other bad strains, as well as leg and foot injuries, incapacitated workers for considerable periods.

Failure to take a firm hold in lifting, carrying, and placing machine parts caused one out of two handling accidents. The injured men were usually engaged in making repairs, adjustments, or changes in equip-

ment. In doing these jobs, the parts slipped and fell on their feet, or struck their legs or toes. Safety shoes were not worn.

Strains occurred under various circumstances. A few employees overestimated their ability to carry heavy objects over rough ground and did not obtain help. Others attempted to lift heavy parts while standing in an awkward position. Operators also sustained strains and hernias in pulling levers while standing in awkward positions. Some levers, however, were difficult to operate and others were in inconvenient locations. The principal unsafe practice, however, was lifting with the back instead of the legs.

9. *No personal protective equipment, particularly safety shoes and goggles.* Injuries due to lack of, or failure to use personal protective equipment were, of course, the eye, toe, and hand accidents. These comprised 4% of all injuries involving general construction equipment. The most serious were fractured toes, which could have been prevented by wearing safety shoes.

Eye injuries were twice as numerous as toe and hand cases. Tractor and caterpillar operators lost time from injuries due to dust particles. Other slight eye injuries, however, occurred under potentially dangerous circumstances. A repairman got a sliver in his eye while driving a piece of iron with a hammer, and a laborer was splashed by hot tar. No reports indicated that goggles were provided, although they were required for such work.

The use of proper gloves would have prevented many of the injuries to hands in handling materials such as cement, cables, and lumber. This was particular true for operators working levers who developed blisters, which became infected and forced them to lose time.

10. *Failing to block equipment, or heavy parts, in repairing.* The use of blocking would have prevented a substantial number of accidents in making repairs and in operating cranes and draglines. A number of very costly accidents happened because operators failed to set outriggers before handling materials on slopes and soft ground. A highly skilled worker was seriously injured, a job delayed, and a crane badly damaged in one accident because this precaution was not taken. Rollers, railroad cars, and other equipment were stopped on inclines without blocking, and before the work was completed, they rolled forward or backward and injured one or more men.

Most accidents occurred in changing or repairing equipment. Heavy parts, such as pans, scrapers, buckets, and gates, were not supported. They fell and caused strains, lacerated hands, and fractured fingers and feet.

11. *Operating too fast, with poor lights, etc., over rough or soft ground.* The number and severity of accidents in driving tractors, euclids, and similar machines over rocky or soft ground warrant more control over operations under these conditions. Operators struck holes in fields and roads and were thrown from the machines, sustaining fractured ribs and painful bruises. Strains also were incurred by attempting to control a bucking steering wheel when operating equipment under these conditions.

Reports ascribed the accidents to driving too fast for conditions, not watching ahead, and having hands on the spokes instead of in the proper position on the rim of the steering wheel. Some night accidents were due to inadequate illumination.

12. *Hooking, coupling, hitching, etc., with hands in pinch point.* Most injuries due to placing hands and fingers in pinch points occurred in attaching hooks to buckets. After a laborer on one job had two fingers crushed in this way, grasping the hook at the top was made standard practice. Other injuries were due to haste—signaling moves before the hooks were properly placed. Fingers were also caught in guiding buckets or other loads through narrow openings.

In loading and unloading box cars, fingers were frequently caught between the door and the jamb in closing the door. A number of workers placed one hand on the edge of the door and the other on the handle; a hard pull drove the fingers on the edge of the door against the jamb. One man had part of a thumb amputated in this way.

13. *Operating too close to power lines and edges of fills, on steep grades, etc.* The outstanding features of accidents at dangerous locations, such as near power lines and the edges of high fills, are their high severity, costly property damage, and the long delays which result. Injuries from contacting power lines were often fatal. It is specifically required that draglines and similar equipment must be operated at least ten feet from power lines.

The greatest number of accidents occurred at the edges of fills, and the worst ones were overturnings. The operators were sometimes caught and crushed under the machines. One instance involved a euclid operator. According to the investigation, the slope of the fill was too steep, and no signalman was provided to direct the operators.

Equipment sometimes got stuck on slopes and was unable to pull out up-hill. This set the stage for an accident. Instead of getting another machine to pull him out, the operator attempted to drive down the hill and overturned. Other factors in overturning were driving into deep holes and dumping big rocks which dropped under the wheels. The power shovel operator on one job disregarded instructions not to load large rocks.

Narrow and poorly constructed ramps were the principal causes of bad accidents in unloading and loading mobile equipment.

14. *Fueling, checking water, etc., unsafely.* Unsafe practices in fueling motors and checking the water in radiators often caused painful burns, in addition to the injuries which were incurred in cleaning and oiling near moving, unguarded fans. They were caused by:

Using gasoline for washing parts.

Fueling gasoline operated trucks while running.

Lighting a match to look into a gasoline tank.

Removing the caps from boiling radiators.

15. *Failing to secure equipment, brakes, booms, and movable parts, before repairing, leaving, and moving.* Accidents due to leaving equipment in gear not setting brakes, and otherwise failing to secure machines and their parts before making repairs, moves, and doing other work were relatively infrequent, but severe. Some were fatal.

Gears must be disengaged. A shovel operator went to lunch and left the swing gear engaged. When he returned and started the machine, the bucket swung into a group of men. Several were seriously injured. Another operator stopped a motor roller in reverse gear. When he started, it backed over a worker's foot.

The ordinary precaution of setting brakes after stopping equipment on grades was also overlooked. Due to this neglect, railroad cars rolled away and caused accidents. Brakes must be set securely. This was sometimes not done in making changes and repairs, and the result was an accident. In one instance an oiler was killed because the operator of a backhoe did not pull the brakes tightly, and the bucket dropped on the oiler. A laborer was killed under somewhat similar circumstances; he was struck by a swinging boom which the operator had neglected to secure properly before the equipment was loaded for moving.

16. *Poor housekeeping on equipment, grounds,*

roadways. Injuries due to poor housekeeping occurred on machines and on the ground. Mud, oil, loose boards, and tools caused slips and falls on machines. On the ground and roadways, loose ties, boards, logs, and wire were tripping hazards. Such materials may also be dangerous in other ways. A



MAKESHIFT DEVICES FOR FUELING RESULTED IN SPILLING GASOLINE ON A HOT MOTOR; THERE WAS A FLASH AND A WORKER WAS FATALLY BURNED.

foreman was caught by a piece of wire which was tangled in the track of a bulldozer, and his foot was pulled under the track and crushed. Loose and heavy boards may also be struck by moving equipment and hurled against workers, as previously mentioned.

17. *Overloading equipment.* Accidents due to overloading equipment were infrequent, but like other infrequent causes, they resulted in serious injuries, delays, and property damage. The worst accidents happened from overloading draglines and cranes; the booms collapsed and struck workers.

Inexperienced operators failed to realize the possibilities of overturning in handling heavy loads with the machine set on soft or sloping ground. In one such accident, an oiler was bruised, and a crane badly damaged.

Reports stated that power shovels were overloaded in at least two ways. The first was filling dippers too full, causing rocks to fall and strike workers in swinging the dipper. A fractured skull was sustained in this way. The second was taking too large a bite and at the same time using too much power. The machines pitched and threw operators and oilers against frames and other parts of the machine.

TABLE II
CAUSES OF GENERAL CONSTRUCTION EQUIPMENT ACCIDENTS

Unsafe Practice or Condition	Total	Draglines, Shovels, Graders, etc.	Tractors, Cater- pillars	Bull- dozers	Concrete Mixers, etc.	Cranes, Derricks	R.R. Cars
ALL CAUSES	100%	100%	100%	100%	100%	100%	100%
1. Backing and turning machines, swinging booms, lowering buckets, etc., without looking, warning, or signaling	17	11	13	19	22	19	34
2. Getting on or off equipment unsafely, unauthorized riding, etc.	12	7	18	23	6	5	28
3. Defective—timing, brakes, clutches, cable, etc.	10	10	10	3	8	13	3
4. Working or walking under skips, buckets, loads	9	12	2	6	8	14	7
5. Failing to retard spark, grip handle correctly, stand correctly, etc., in cranking	9	10	19	3	3	3	—
6. Oiling, adjusting, repairing, etc., without stopping machines	8	8	2	3	20	10	—
7. Unguarded and inadequately guarded fans, gears, etc.	5	5	3	2	12	7	—
8. Insecure grip, too heavy load, lifting with back, etc. in handling by hand	5	3	9	6	4	3	6
9. No personal protective equipment, particularly safety shoes and goggles	4	8	1	3	5	2	1
10. Failing to block equipment, or heavy parts in repairing	3	4	3	3	1	3	4
11. Operating too fast, with poor lights, etc., over rough or soft ground	3	5	6	5	—	—	—
12. Hooking, coupling, hitching, etc., with hands in pinch point	2	3	2	3	—	2	4
13. Operating too close to power lines and edges of fills, on steep grades, etc.	2	2	3	5	1	1	—
14. Fueling, checking water, etc., unsafely	2	1	4	2	1	1	—
15. Failing to secure equipment, brakes, booms and movable parts, before repairing, leaving, and moving	1	1	1	2	1	1	3
16. Poor housekeeping on equipment, grounds, roadways	1	3	1	2	1	2	—
17. Overloading equipment	1	3	1	2	1	2	—
18. Insecure hitching to loads, wrong use of equipment, losing control, using hands instead of tools and cases not otherwise classified	6	6	2	5	5	14	7

(This special study was made by G. G. Grieve, statistician of the National Safety Council, in collaboration with the Statistical Section of the Safety and Accident Prevention Branch. The services of the former are gratefully acknowledged.)

Summary. It is obvious that far greater attention must be given to the elimination of the causes of accidents resulting in serious injuries, heavy property damage, and long lay-ups of equipment. While marked improvement was effected in the 1942 injury frequency rate, this was accompanied by a much smaller decrease in the severity rate as compared with 1941. There was little improvement in the frequency and severity of serious accidents.

The principal source of serious accidents involves the operation of draglines, tractors and other general construction equipment. Motor timing must be more carefully checked, and brakes, cables, and clutches must be more frequently and thoroughly inspected and kept in first class condition. Supervisors must devote more time to directing equipment operations, be more positive and effective in

the instructions they give to workers in safe practices, and the enforcement of such practices must be more strict.

Special attention must be given to:

1. Controlling the movements of tractors, cranes, and other mobile equipment by warnings and signals.
2. Keeping clear of moving equipment and loads.
3. Unauthorized riding on railroad and other equipment.
4. Safe practices in cranking motors.
5. Stopping cables, gears, and motors before oiling, repairing, and otherwise working on them.
6. Guarding gears and other dangerous parts of machinery and protecting against falls into ditches, man-holes, and other openings by barricades and rails.

(Continued on page 18)

Stabilized Crushed-Rock Surfaces¹

By J. E. HERZOG

County Highway Engineer, Steele County, Minn.

HEAVERY truck traffic on several Steele County highways had resulted in an excessive loss of crushed-rock surfacing material. This prompted a search for a higher type of wearing surface that would meet both traffic requirements and budget limitations. We had the necessary funds, and determined on the construction of a stabilized crushed-rock wearing course requiring no critical materials.

A badly worn 6-mile length of State Aid Route 8 was selected for the initial project—the first of its kind undertaken in Steele County. Since the work was experimental and few if any experienced contractors could have been expected to bid, it was decided to handle the stabilization operations with county maintenance forces. A contract for delivery of crushed limestone was awarded to the Klemmer Construction Co., of Owatonna.

Specifications required gradation to meet Minnesota Department of Highways specifications for Class 5 aggregate. The material was applied at the rate of 600 cu. yd. per mile over a 24-ft. width. When crushing operations were begun, samples were analyzed and the aggregate was found to meet specifications, but with fines of No. 10 size and smaller near the lower limits.

This material was applied over a ½-mile length. It was found that the fines were insufficient in quantity to bind the coarser material, and a ragged surface resulted. The crusher rolls were then adjusted to produce the following gradation, which gave excellent results:

Passing	Per Cent
¾-in. sieve	100.0
⅝-in. sieve	94.8
⅜-in. sieve	70.0
No. 10 sieve	31.0
No. 100 sieve	14.6

By trial and error a satisfactory procedure was developed for handling the stabilization. A ½-mile length of road was built per day. The windrow of crushed rock was formed to an even shape and mixed dry with a motor grader. The windrow was then flattened and water was applied with a 1,500-gal. distributor tank. The wet material was mixed in place

- Stabilized crushed rock surfaces constructed with well graded stone, in the opinion of the author are better suited to modern traffic conditions than the water-bound macadam so widely used in the past. In the present article he describes this type and his experience with it.

until it had the consistency and general appearance of a workable concrete. During dry periods, evaporation loss made frequent watering necessary. Thorough mixing was found to be as essential in this work as in bituminous construction.

Following the mixing operation, the roadbed was primed with water to settle the dust and form a base to which the wet aggregate would adhere. It was found that if the base were not prepared in this manner the material would shove ahead of the mold-board when spread, leaving open spaces in the mat. This simple detail was highly important in obtaining satisfactory results. The wet mix was spread uniformly and shaped to an A-shaped crown of ½ in. per ft. An experienced operator is required, since excessive handling during the spreading will result in segregation of the aggregate, which dries rapidly after being spread.

Rolling was begun immediately after the material had been spread, and continued until no further compaction could be obtained. It is necessary that rolling be continuous during the drying of the material, to obtain maximum density. A steel-drum roller weighing 5 tons was used for this work. It had a tendency to pick up the mat when rolling was first begun, and we believe that a rubber-tired roller would be superior to the metal drum for this work.

After rolling had been completed, calcium chloride was applied at the rate of 1 lb. per sq. yd. over an 18-ft. width. The chloride penetrated during the night, and on the following morning the road was ready for traffic.

The results obtained on this first job were considered satisfactory, and a total of 18 miles of road was surfaced during the remainder of the season, including 1.7 miles of village streets.

After the procedure described above had been developed, it was found that three trained men could handle ½ mile of work per day on a carefully planned schedule. Shaping of the windrow was begun at 7 a. m. At the same time the driver of the

¹ Reprinted from *Better Roads Magazine*.

sprinkler truck filled the tank, and a third man began loading a 1½-ton truck with chloride. After delivering the chloride to the job site, the driver of this truck serviced and operated the roller, which was left out on the job.

Watering and mixing were begun at approximately 8 a. m., this operation continuing until approximately 11 a. m., at which time spreading was begun. Spreading required about 2 hours. After spreading, rolling was begun and continued until about 4:30, when all three men applied the chloride, this work requiring about ½ hour.

Bad weather and breakdowns occasionally interrupted this performance, although some work was done in freezing weather without difficulty. It required more rolling to obtain compaction, however.

The cost of the stabilization was very low, average cost per mile running as follows: watering, \$27; mixing and spreading, \$40; rolling, \$14; calcium chloride, \$140; application of chloride, \$11; total \$232, including labor and equipment rental but not including the cost of the crushed rock.

After 3 months of use the road became slightly dusty and pitted. It was bladed lightly following a rain, and chloride was applied at the rate of 1/3 lb. per sq. yd. The surface immediately set up, and was still in good condition after 2 months of use when the freeze-up came. From observations made over this period we estimate that this surface will require three such treatments per year, and possibly four in an extremely dry year, to keep the surface dust-free and smooth.

Added Cost Less Than One-Third of Material Saved

The cost of maintenance will average about \$90 per mile per year more than blade maintenance, but we anticipate a saving of material in the amount of \$300 per mile. The hard, dust-free surface also provides better service to road users.

The surface described was placed on a grade that had been built in 1939. Fill material had been taken from side borrow ditches, with no selection of material. The soil in this area was generally stable, however, with the exception of a few short stretches where peat was encountered. Crushed-limestone surfacing had been applied at the rate of 1,000 cu. yd. per mile. Most of this material was subsequently lost by heavy traffic action, but a considerable amount of it mixed with the subgrade soil to form a fairly solid base through the traveled part of the surface.

We have since built stabilized crushed-rock surfaces over ordinary gravel-surfaced roads where no attempt had been made to construct a base, with equally satisfactory results.

This type of construction is well adapted to county organizations. The work can be handled by maintenance forces if desired, and very little equipment is required beyond that used in regular maintenance work. It is especially advantageous during the present emergency, since no critical materials are involved, and a genuine saving in cutting edges, tires and equipment can be effected in the maintenance of this type of surface. This saving, of course, will lose some measure of its present value after the war is ended.

We believe, however, that this method of construction is a definite step forward in the development of a better low-cost surface. Increasing traffic, speeds and wheel-loads are rapidly making obsolete the waterbound surfaces so widely used on secondary roads, and the mechanical progress growing out of this war will result in a still larger gap between the design of the road surface and the vehicles that travel upon it.

General Construction Equipment Accidents

(Continued from page 16)

7. Safe practices in handling materials by hand.
8. The use of personal protective equipment, especially safety shoes and goggles.
9. Blocking equipment properly on grades, and blocking heavy parts in repairing or changing them.
10. Methods of operating equipment over rough ground.
11. Training workers in the safe way to hook, couple, and hitch without injuring the hands.
12. Safety requirements in operating close to power lines, edges of fills, and similar dangerous locations.
13. Safe practices in fueling and servicing equipment.
14. Procedures in securing equipment, brakes, booms, and other movable parts before repairing, leaving, or moving.
15. Housekeeping on equipment, grounds, and roadways.
16. Handling loads of proper weight with power equipment.

Concrete Pavements Without Steel¹

By L. E. ANDREWS

Regional Highway Engineer,
Portland Cement Association,
New York, N. Y.

CONSTRUCTION practices, as carried on in the past by the states and other roadbuilding agencies, have shown a wide variety of concrete pavement design, in so far as use of steel and jointing arrangements are concerned. Service records of pavement performance on these projects have helped to support the theoretical considerations which must be set up in design procedure. To determine where and in what quantities steel may be eliminated, it is desirable to analyze its function.

In general the unit distribution of military loads is such that the usual slab thicknesses required for normal heavy-duty civil use need not be exceeded. Therefore this paper is concerned chiefly with changes in other design details to meet the critical materials situation.

Distributed Reinforcement

Distributed steel in the form of bar mats or wire mesh is used to hold the faces of slabs closely together where intermediate cracks occur between joints, and thus avoid free edges and corners. The amount of distributed steel commonly used does not increase the load-carrying capacity of uncracked slabs nor does it prevent cracking. However, after cracks occur it holds them tightly closed, thus providing load transfer across irregular slab faces.

In the thickened-edge type of design it is important that load transfer be maintained where intermediate cracks occur in order that otherwise weak sections may be avoided. Where a uniform depth of slab is used, the edges at open cracks will be as strong as the exterior edges.

The infiltration of dirt and sand into cracks is minimized where they are held closely together by steel. Such progressive infiltration of incompressible foreign material is generally considered an important factor in developing high compressive stresses and ultimate "blow-ups" in existing pavements.

There is ample evidence from existing pavements that proper jointing will greatly reduce or practically eliminate intermediate cracking. Since the principal function of distributed steel is to insure close con-

tact of slab faces at cracks, which may occur between joints, it is logical that the adoption of an adequate jointing design is the first and most important step in reducing or eliminating the need for such steel.

Condition surveys and experience over a period of years in many states throughout the country have established the conclusion that adequate crack control can be secured by the use of joints spaced to form the following slab lengths, depending on the kind of coarse aggregate used in the concrete:

Types of Coarse Aggregate	Slab Length (ft.)
Granite and trap rock	25
Limestone	20
Flinty limestone	20
Gravel: Calcareous	20
Siliceous	15
Less than ¾ in. size	15
Slag	15

These slab lengths can be secured most economically by a combination of expansion and intermediate contraction joints. The dummy groove is the most popular method of forming contraction joints. It provides an excellent anchorage for the joint sealing material, thus offering much better protection against infiltration of foreign materials than a similar seal on the slab surface at an ordinary crack.

Tie-bars are used principally across interior longitudinal joints to hold slab faces closely together, thereby preventing free edges in the interior portion and maintaining balanced structural strength between the interior of the slab and the thickened edge. Adequate load transfer, however, must be accomplished by tongue-and-groove construction or aggregate interlock below the dummy groove, depending on the type of joint detail desired.

Tie-bars are not needed where the pavement is of uniform depth, since both the interior and exterior edges have the same structural strength. However, it may be desirable to supply them under some conditions to prevent slab separation and possible vertical displacement along longitudinal joints.

Tie-bars will not be needed at interior longitudinal joints of thickened-edge slabs where such edges are thickened in a manner similar to the exterior edges, unless required to prevent slab separation. For two-lanes-at-a-time construction, the longitudinal dum-

¹ Reprinted from "Civil Engineering" for May, 1943.

my-joint groove should be cut to such a depth that the concrete below the groove is at least one inch less in thickness than the interior thin portion of the slab. This is essential to insure that the resulting crack will occur at the dummy joint.

For lane-at-a-time construction, it is recommended that a tongue and groove be provided at the longitudinal construction joint in order to keep adjacent slabs at the same elevation under conditions of use, although this is not required for transfer of load to maintain structural balance.

In some localities a deformed metal dividing plate with tie-bars has been used at the longitudinal joint to form a plane of weakness, to transfer load, and to tie the slabs together. This type of construction can be eliminated by substituting the designs previously described.

Slip dowels or other metal devices are installed across transverse joints for the transfer of load and to provide free longitudinal movement of slab ends at the joint. Their primary purpose is to transfer part of the wheel load from one slab to the other and in this way reduce stresses in slab ends and corners. A secondary purpose is to prevent vertical displacement of the slab ends under some sub-grade and traffic conditions.

In thickened-edge pavements, slip dowels provide a structural balance at transverse expansion joints by avoiding critical stresses from wheel loads in the thin section of the slab and at corners. The same purpose is served at transverse contraction joints where there is no aggregate interlock because of the small size of the coarse aggregate used, or where vertical butt-type construction joints are installed. The only function of slip dowels in uniform-depth pavements, except at the slab corners, is to prevent vertical displacement.

Slip dowels or similar devices are needed to transfer wheel loads at transverse expansion joints unless some other adequate means is provided to strengthen or support the slab ends. The quantity of steel required for dowels can be materially reduced by placing the expansion joints at long intervals.

The Problem of Expansion Joints

Research data and field observations indicate that a rather limited amount of expansion space, much less than commonly used, will protect the pavement from critical compressive stresses. Also, if dummy-groove contraction joints are spaced to control cracking and are properly maintained to exclude infiltration of

foreign material, very little expansion space is needed.

There are distinct advantages in providing only sufficient expansion space to keep compressive stresses within safe limits. Under these conditions the slab will be under compression at temperatures above that obtaining at the time of placement. Then at lower temperatures the contraction-joint opening will be at a minimum, which is important in providing load transfer at these joints. The additional compressive stress caused by longer spacing of expansion joints will actually be beneficial in reducing tensile stresses caused by warping and loads.

Factors affecting expansion space requirements are the variations from the temperature at which the pavement was placed, and the possible infiltration of inert material into cracks and joints. Field observation and theoretical analysis indicate that with normal materials, under average climatic conditions and with the contraction-joint interval recommended, $\frac{3}{4}$ -in. expansion joints at 400 to 600-ft. spacings will protect the pavement from critical compressive stresses. Expansion joints may be omitted entirely where conditions are particularly favorable. Dowel steel can be reduced 70 to 80 per cent by using $\frac{3}{4}$ -in. expansion joints at 400 to 600-ft. intervals in place of the 120 ft. required by some official regulations.

Dowels may be entirely eliminated at transverse expansion and construction joints and a structural balance may still be maintained by thickening the slab ends so that they require no support from abutting slabs. Experience and studies of performance indicate that the slab end should be thickened by a straight-line slope from the normal cross section at a point 5 to 10 ft. back from the joint to such depth as required at the joint.

When dowels are to be eliminated in thickened-edge pavements, it will be necessary to thicken the slab ends at expansion and construction joints in order to maintain a structural balance. Also, slab-end thickening will be required in the case of uniform-depth pavement in order to secure the most economical slab design. Otherwise the pavement would have to be uniformly of the thickness required for structural adequacy at the free corners. On heavy-duty pavements, and particularly where subgrade conditions are unfavorable, it may be found desirable to provide dowels or other devices to prevent vertical displacement—"stepping off" of slab ends ahead of the joint in the direction of traffic. Some trouble of this sort was experienced in several northeastern states until remedied by appropriate design.

Still another method of eliminating dowels is to support the slab ends on concrete subslabs cast in place ahead of normal pavement construction. The first use of this type of construction in this area was about 8 years ago in New York State. Since then it has been used in New Jersey. The supporting slabs have been 4 to 6 in. thick and 4 to 5 ft. wide. Results have been quite satisfactory. Designs using additional concrete at the slab ends will usually cost more than dowels, but such costs may be justified at this time in order to conserve steel.

Elimination of Dowels at Contraction Joints

When expansion joints are spaced at relatively long intervals and intermediate dummy contraction joints are spaced at the intervals here recommended, dowels will not be required for load transfer across the contraction joints. When the pavement is in compression, the contraction joints will be tightly closed.

Where contraction joints are spaced so as to prevent intermediate cracks from occurring, the amount of contraction of each of the relatively short slabs will be very small and not sufficient to open the dummy contraction joints and interfere with aggregate interlock below the dummy groove and transfer of load across the joint. Observations and studies of joint performance in many states throughout the country show that entirely satisfactory results may be expected with undoweled dummy contraction joints.

The design principles that have been outlined are now developing into accepted practice throughout the country. A typical design using no steel, as published by the Portland Cement Association, is shown in Fig. 1. In Fig. 2 are shown variations of this design to be used when conditions warrant.

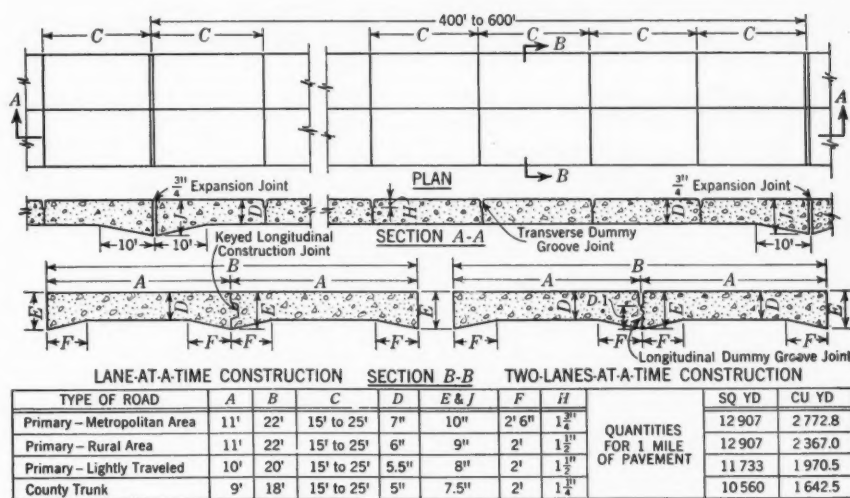


FIG. 1. TYPICAL CONCRETE PAVEMENT WITH NO STEEL Portland Cement Association Design

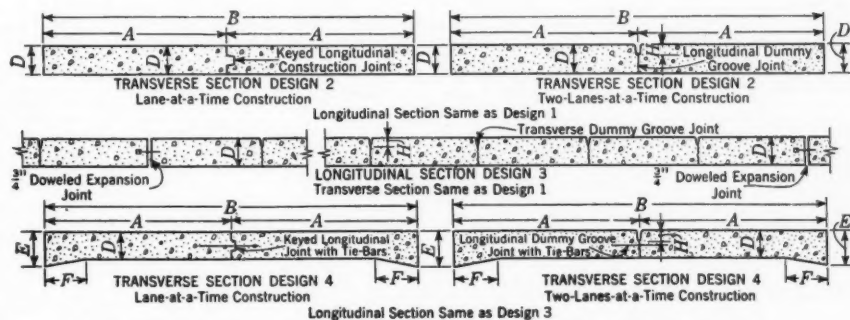


FIG. 2. PAVEMENT CROSS SECTIONS FOR VARIATIONS OF DESIGN I (FIG. 1)

Most of the highway departments in the northeastern states have adopted plain concrete pavement designs, with dummy contraction joints at an average of about 20 ft. apart. Spacing of transverse expansion joints has varied. The average has been about 120 ft., but on some projects spacings up to 500 and 600 ft. are being used.

The military establishments and the various aviation agencies have also adopted plain concrete pavement designs very similar to those here described. The large airport programs which have been under construction for some time, based on such designs, are showing very satisfactory results. The use of short slab lengths (15 to 20 ft.) with relatively long intervals between expansion joints, has proved the merit of this crack-control design.

Flight Strips Keep 'Em Flying

"SOMEWHERE on the Middle Atlantic Seaboard" is America's first flight strip. Opened for operations last summer, it is already credited with saving an Army bomber. Hemmed in by storms, the bomber received reports that low ceilings closed every airport within safe flying distance. Having reports on the recent completion of a flight strip 30 miles away, the pilot set his course in that direction, found the field open and made a safe landing, saving ship and crew.

This flight strip opened the \$10,000,000 program authorized by Congress in the Defense Highway Act of 1941. Additional flight strips have been and will be built by the Public Roads Administration, in co-operation with the Army Air Forces. Designed to supplement and augment the regular air bases, a flight strip is defined as "an area of land with clear approaches located adjacent to a public highway for use as an auxiliary landing field for aircraft."

Purpose of these single-runway strips is twofold. First, there is recognition of the folly of concentrating large numbers of aircraft on primary air bases where they would be vulnerable to enemy action. In brief, the strips augment our active bases while affording a means of dispersal of aircraft. Second, the plan looks to post-war increases in civilian and transport flying—sees it promoted by the strips, which will provide civilian flyer facilities, offer auxiliary utilities to transport craft or afford air-feeder service for small cities or groups of towns.

The first year of operation has effectively demonstrated the value of the flight-strip program. Ten or 15 emergency landings have already been made on a Pacific Coast strip. The life of a soldier at one northern post was saved when two Army doctors were flown in at night to perform an emergency operation. Because of a snowstorm, the regular airfield could not be used. Army trucks were, therefore, lined up to illuminate the flight strip with their headlights so that the mercy plane could land and take off.

Furthermore, the flight-strip plan is assuming international significance. Today, it is reaching far beyond our borders to aid the worldwide service of our Air Transport Command. In one case of overland operation on a foreign route which will undoubtedly be vital in our 1943 war effort, flight strips are now augmenting the few available airfields. Easily and quickly constructed, the strips are great-

ly expediting the flow of men and materials to critical zones.

Use of flight strips as points of call for cross-country trainees is also recognized as feasible. Groups of students and instructors may fly to such strips for training periods, thus relieving congestion at the major base. Practice of aerial gunnery and bombing may well be conducted at strips which are at a distance from centers of population. These uses would, of course, be in addition to the military maneuver, A. T. C. ferrying and coastal defense utilization of the strips.

From a military standpoint, the primary value of flight strips lies in the fact that the building of such landing facilities throughout the country makes possible the dispersement of the flying forces so that they could operate effectively without being concentrated as targets for enemy bombers at large central airports. In a country with extensive open areas such as the United States, the dispersion of the defending air force is more practicable than the use of underground hangars at air terminals.

While a number of the flight strips now being completed for the military program are not so located as to be of greatest value for post-war use, these strips are justified as a war measure. The majority, however, have been located to fit into the planned expansion of air transport and private flying of the future. This is particularly important in view of the fact that lack of comprehensive airfield facilities had put a serious strain on our domestic aviation activities prior to the war. Air mail, passenger and cargo business was then recording an estimated overall rise of about 40 per cent per year. Civilian flying was also in a steep climb.

The latter activity has been given great emphasis by the war. The aviation cadets now training to speed victory will furnish a nucleus that will undoubtedly promote widespread private flying in the post-war period. For these new pilots, adequate landing facilities will be imperative and the flight-strip program provides an answer. At the start of the war fewer than 500 cities enjoyed air service. But after the war there is every possibility that air service can be brought to as many as 5,000 communities. It is reasonable to predict, therefore, that the construction of these auxiliary landing areas will be greatly expanded after the war, augmenting the airport program.

Government Questionnaires and Reports¹

By **STUART A. RICE**

Assistant Director in Charge of Statistical Standards, Bureau of the Budget, Executive Office of the President.

I AM grateful for this opportunity to address some of the "victims" of Government questionnaires and reports. In this matter I am your ally, since it is my responsibility to minimize your questionnaire burdens. At the same time I am aligned against you since I represent the Federal statistical services as a whole and must assist them to obtain necessary information. In short, I occupy the position of a bureaucratic buffer, standing between you and your questionnairing persecutors; and am therefore subject to plaudits—or other commentaries—from both sides.

The *Pittsburgh Press* recently remarked "Because the President never helped Congress to economize with a scalpel, Congress is operating on the over-stuffed bureaucracy with a meat ax." This is certainly not true of Government questionnaires and reports, in respect to which the use of refined instruments by an agency of the Executive Office of the President has been ordered by the Congress itself. Many in this audience, I feel sure, would prefer bold swings of the meat ax; but that is neither the right way nor the legal way of working on the patient. Statistical coordination and the simplification of Federal reports are meticulous tasks. They require a careful examination of statutory requirements and administrative needs for data, thorough attention to alternative ways of meeting these needs, a consideration of the ability of respondents to supply the information sought, an analysis of plans for collecting, processing and using the proposed information, a study of possibilities of sampling or of technical improvement in the plans, a review of possible duplications with other agencies, and many other related matters. The Congress has prescribed an operation on Federal questionnaires and reports, but instead of taking an instrument into its own hands it has appointed the Director of the Budget as Surgeon and equipped him with a set of surgical instruments. His appointment and his set of tools will be found in the Federal Reports Act of 1942. As the assistant in charge of the operating room I will be happy to tell

- At long last the businessman, overburdened with the need of making out a constantly increasing number of questionnaires and reports, finds some promise for relief in this situation through the creation of The Advisory Committee on Government Questionnaires. For the hope that it offers for relief from a serious problem as well as for its contribution to a better understanding of the need for certain questionnaires and reports, the following article should prove of real interest.

you about our operations; but first allow me some general comments upon the disease with which we deal.

We American people are given to questionnairing quite as naturally as we are given to tinkering with tools. We send out questionnaires to obtain facts. We are a factual-minded people and assume that in matters of importance it is unwise if not sinful to act without factual premises. Our thinking still contains many magical elements, particularly in respect to statistics. We assume that statistics are needed as a basis for policies and as a guide to decisions or activities. But sometimes, alas, there is actually little relationship between our data and the actions we presume to base upon them.

One evidence of American factual-mindedness is the public pressure to which most governmental agencies are subjected for information on all manner of subjects. Among others, businessmen want data on production, inventories, prices, wages or trade. It is often naively assumed that the Government can obtain information by some process of spontaneous creation, or at least from somebody other than the petitioner. I once received a letter from a very irate mid-western manufacturer. He was outraged at the Government's request for information concerning his affairs. Before I had collected my wits and decided how to answer, my secretary announced the arrival of an emissary from the industrial organization of which my correspondent, the manufacturer, was the leading member. The emissary demanded that the Government produce bigger and better statistics concerning his industry.

In my opinion the greater part of our national fact-gathering, public and private, is necessary (or at least useful) and rational; but I believe that much of it is unnecessary (or of uncertain value) and has precisely the character of a primitive fetish. It illustrates the component of magical thinking which modern men have inherited from remote ancestors

¹ Presented before the Economic Club of Detroit, Detroit, Michigan, April 5, 1943.

and mixed up with their rational ideas. All Americans share to some degree an irrational belief in the magical efficacy of facts, statistically assembled, for solving problems.

Some years ago my advice was sought by a committee of businessmen which had been asked to develop a public program for dealing with unemployment. The draft of the Committee's report was the result of much hard work. Its main recommendation proposed the governmental collection of certain statistics concerning the labor market. On the basis of these statistics, it was felt, a further program of action might be formulated. The committee's satisfaction with its labors turned to chagrin when it was found that the information called for was already available. No one knew how to use it! With the best intentions in the world, these men had been kidding themselves. Their proposal for the collection of statistics was actually a psychological substitute for incisive thinking and decisive action.

A similar "escapist" phenomenon had some recent publicity. Certain reformers attacked the evil of Government questionnaires by the use of homeopathic remedies. Seeking, perhaps, to apply the wisdom distilled from age-long experience in another field of endeavor, these anti-questionnaire reformers took a hair of the dog that bit them, and issued a questionnaire! I could compile a list of at least a dozen such instances.

Much of what I have said concerning the psychological foundations of "questionnairing" is applicable to "paper work" and "red tape" in general. For most of us incisive thinking, prompt decision and decisive action are painful. We seek for substitutes in routine, in shuffling papers and in collecting more information. Now we are in the midst of a desperate war, to the winning of which all else must be subordinated. Under the harsh realities of wartime shortages of personnel and office equipment our lazy peacetime devices must be sloughed off. Our routines, our papers and our statistics, so far as they are retained, must be justified by the necessities of a lean but efficient economy, stripped for action.

Hence it is that efforts to simplify the mechanics of organization are world-wide. Even in Germany, where delinquent respondents to Government questionnaires and report forms are legally liable to the death penalty, there are audible complaints that this is a "paper war."

Personnel from my Division of the Bureau of the Budget, to quote a War Department letter, "made an analytical study of about 960 recurring reports which

were being made in various parts of the War Department. As a result of their work many hundreds were eliminated and large numbers of the remaining ones were greatly improved. The eliminations have resulted in doing away with perhaps a million pages of reports per annum and the record systems of the Army have been greatly improved."²

These, please note, were internal, administrative report forms. The Navy Department, in a similar housecleaning eliminated approximately 650 or 55 per cent of its internal forms.

I cannot refrain at this point from repeating a War Department story, hoary with age, which is fortunately without present application to the service departments. It seems that certain-hand-written records of the Indian Wars were occupying space that was needed for an officers' card room. A formal recommendation that the records be destroyed travelled through many official layers, accumulating indorsements, until it eventually reached the officer in command. His decision was firm and uncompromising: the records might be destroyed, provided they were copied first!

Perhaps the most striking recent instance of paperwork elimination was discussed in testimony before the House Committee on Foreign Affairs on the extension of the Lend-Lease Act.³ Referring to "reciprocal lend-lease" for the aid of our forces in the United Kingdom, an army witness reported the estimate "that it would require half a division of trained personnel to place valuations on materials received . . . with sufficient accuracy so that a sterling or dollar record could be maintained." On stations occupied both by British and United States troops, and particularly in the case of shared airfields, "no records are maintained as to whether the articles issued . . . are delivered to United States or British troops." "It has not been deemed advisable," says the Committee "either by the United States Army or by the officials of the Office of Lend-Lease Administration . . . to attempt to maintain dollar records of reverse lend-lease."

This tale is a sad one for Anglophobes and for the more doctrinaire exponents of the developing science of cost accounting. Most of us will rejoice at the decision to get on with the war and to leave inter-allied cost accounting to the historians of the next generation.

Let us return to the subject of operations upon government questionnaires and reports. To begin

² Letter of June 27, 1942 to the Director of the Budget from General Leonard P. Ayres.

³ 78th Congress, 1st Session, Report No. 188, pp. 7-8.

with, of what does the public specifically complain.

It does not ordinarily complain of supplying information which it believes necessary for the Government to have. But businessmen do protest against the use of their inadequate office staffs and facilities to provide information for which they see no need.

This protest points at two governmental obligations: First, clearly to establish through an orderly process of review that information sought by Federal agencies is actually required and cannot be obtained in other, less burdensome ways. I was recently told by several businessmen that the "Manning Tables" of the War Manpower Commission were an unmitigated burden and could serve no useful purpose. When it was explained that these forms were intended to assist in the release of personnel into the armed services with the least disruption of working forces, and that the forms had been approved after a systematic review in which businessmen had participated, their opinion changed. The explanation appealed to an appreciation of "due process" which orderly-minded people possess.

It also illustrates the governmental obligation to take respondents into confidence concerning needs for information. Too often in the past the public has been left in the dark concerning the objectives and necessities which have dictated a particular data request. This appears to express an attitude of condescension when it is usually only thoughtlessness. Bureaucracy is thus exhibited at its worst. Fortunately much recent progress can be noted. Instructions have become more informative, employing language which is intelligible. The Office of Price Administration is a leading candidate for an award of E for Excellence for its progress in this respect.

Another frequent complaint is more difficult to remedy. Says the average businessman, why cannot the Government adapt its reporting requirements to the way I keep my books? The answer is that "few groups of respondents have even approached the development of uniform record systems. For the larger part of the field of business it is often difficult to devise a question which will be consistent with the record-keeping methods of all those who must answer it."⁴

The standardizing of business record systems, industry by industry, will occur slowly and be somewhat painful. Yet it is a task in which cooperation between government and business will offer advan-

tages to each. However, standard record systems offer no guarantee that emergencies will not require the collection of data not easily available.

Somewhat similar to complaints about record-keeping requirements are those concerning the cruel and unusual punishments inflicted upon business by inadequate form design. There are off-size forms; forms of exaggerated bed-sheet dimensions, too big for standard-carriage typewriters; forms which are lacking in logical arrangement. This is an area in which much simplification and standardization is being effected. The Advisory Committee on Government Questionnaires, the Bureau of the Budget, and other Federal agencies among which WPB and OPA should be specially mentioned, are working together to improve formats and form designs.

But perhaps the most usual complaint is not discriminating. Mr. Harvey Campbell says "They all want to express their general annoyance, but they don't seem to want to put the finger on any one item." This annoyance, I take it, reflects the number, volume and costliness of governmental reports, in relation to business operations. The situation is sometimes reminiscent of the fabled Mississippi River Steamboat. When the whistle was blown the engine was stopped. Many a businessman spends so much effort in preparing his government reports that he feels lacking in strength to direct his war production.

In ways of which I shall presently tell you, many reporting burdens have been forestalled or removed. Nevertheless, it is my sincere opinion that after all remedies have been applied the burdens will still be heavy. Those which remain should be viewed as a necessary cost of doing business, along with internal accounts and control systems, to be assimilated into the working procedures and habits of business organizations.

It must be remembered that many general authorizations for the collection of data along with some specific directives are contained in Federal statutes. At least one hundred Federal bureaus and agencies have received such statutory authority and feel called upon to exercise it. In peace times three quarters of all reports from the public serve the direct administrative needs of these agencies. At present all Federal data-requests purport to be essential for war-time purposes. But since most of the statutory authorizations are phrased in general terms, they tend to overlap. In our "decentralized" statistical system, some duplication is inescapable.

Instead of prescribing exact specifications of the data which Governmental agencies may collect, Con-

⁴"Report of the Central Statistical Board on the Returns Made by the Public to the Federal Government," 76th Congress, 1st Session, House Document No. 27, p. 22.

gress has evolved the policy of providing for a centralized review and coordination of the statistical activities of the several agencies. The Central Bureau of Planning and Statistics during the First World War, the Central Statistical Board during the great depression and its direct successor, the Division of Statistical Standards in the Bureau of the Budget, are all in the line of succession through which this policy has become established.

The Federal Reports Act of 1942, signed by the President on Christmas Eve in a spirit of sincerely sympathetic concern over the reporting problems and harassments of American business, was a consequence of the wartime expansion in Governmental requirements for information. To quote Mr. Eric Johnston, President of the United States Chamber of Commerce in a letter to the Director of the Budget, "The demands for basic, essential information are enlarged in time of war. This comes about because of the increased responsibilities which the government must assume in administering such complex activities as allocating scarce materials to war and essential civilian industries; rationing various products, and keeping prices from getting out of hand. All of the essential war activities must be carried on effectively and efficiently, and this requires from business concerns and from individuals an increased volume of basic information."

A large majority of informational requests now originate in the new war agencies, with the War Production Board far in the lead. However, the old-line statistical agencies like the Bureau of the Census and the Bureau of Labor Statistics are being utilized directly in the war program and their normal work has been reduced to negligible proportions. The effect of conversion on the collection of data may be illustrated by the Bureau of Mines. Because minerals play such a vital part in the munitions program it was inevitable that fact finding in this area should be expanded. The number of Bureau of Mines questionnaire forms has increased about 50 per cent from 196 to 289. Since most of the increase was in monthly forms the number of canvasses per annum has more than trebled, from 419 to 1,402; and the number of individual reports from respondents has grown by nearly five-fold, from 170,000 per year to more than 800,000. The Bureau believes that its huge expansion as a report collecting agency has been accomplished with the willing cooperation of a very great majority of its approximately 86,000 respondents.

As Mr. Johnston has rightly said, the heavy growth in the volume of information necessary to carry on

the wartime affairs of the Government "makes it all the more important that the requests for information should be kept at a minimum and be put in such form as to make for practicable replies and utilization of their contents."

The Bureau of the Budget has formulated a program of control to meet this specification.

We are placing upon individual departments and agencies the responsibility for establishing central points of internal clearance and control over report forms originating in their own subordinate units. This retains in the Bureau of the Budget a responsibility for final review and approval while enabling it to devote more attention to the broader issues of inter-agency coordination. To date the Departments of Agriculture, Commerce, Justice, Navy and War, together with the Board of Economic Warfare, Federal Power Commission, Federal Security Agency, Office of Price Administration, War Manpower Commission, and War Production Board have established these internal control units.

In practice, an important form will often receive the continuous attention of both the Bureau of the Budget and the agency control office, beginning at an early stage in its formulation; so that the final steps of clearance and approval (if the form survives) may be rather perfunctory. In theory the form is cleared and approved by the agency control officer in a preliminary screening process before it reaches us.

All forms which are to be sent to ten or more respondents by or under the sponsorship of any Federal agency must, with a few exceptions, be cleared with the Bureau of the Budget and receive its approval. The exceptions include the General Accounting Office, several of the Treasury bureaus such as the Bureau of Internal Revenue and bank supervisory agencies to the extent that such agencies obtain reports from banks for supervisory purposes. The requirement of Budget clearance and approval extends to any reporting or record-keeping requirement embodied in a governmental order or regulation.

Each Federal form or questionnaire approved by the Bureau of the Budget is assigned an approval number and usually an expiration date. When the form is printed or otherwise multicopied, the approval number and expiration date must appear prominently, usually on the upper right-hand corner of the face sheet. Without these symbols the form should be regarded by the respondent as at least suspect, and need not be returned until he has satisfied himself by inquiry that it has in fact been approved.

It may be of interest that the approval number is a code which indicates to us the identity of the originating agency. The expiration date is that beyond which the form is invalid, unless it has again been reviewed and approved in our office. The date appearing on a repetitive form should serve the respondent as a tickler, suggesting the approximate time at which any complaints or suggestions concerning the form should be in our hands if they are to receive effective consideration.

Government orders or regulations which include reporting or record-keeping requirements must include in their texts a statement of Budget Bureau approval. Please notice that such approval does not extend to the order or regulation itself but only to the reporting or record-keeping requirements therein.

The measures which I have outlined will depend for much of their effectiveness upon the alert cooperation with us of the recipients of informational requests from other Government agencies; and they are so intended. Only when refusal to answer unauthorized inquiries becomes general can bootlegging of forms be entirely eliminated.

A major element in our control program employs machinery for cooperation with the Nation's business community and looks toward a better adaptation of Government questionnaires and report forms to business facilities and interests. At the request of the Director of the Budget, an Advisory Committee on Government Questionnaires was established about six months ago by five business organizations, the American Trade Association Executives, the American Retail Federation, the Controllers Institute of America, the National Association of Manufacturers and the Chamber of Commerce of the United States. The viewpoints and experience of American business are increasingly channelled through this Committee and brought to bear through the Bureau of the Budget on the formulation of Government report forms and questionnaires. The Committee's work is accomplished through numerous exploratory subcommittees, subcommittees in particular fields of business interest and ad hoc panels on particular reporting problems.

I am glad to report to you that the Advisory Committee on Government Questionnaires has already been of tremendous assistance, not only to my office in the effectuation of its control program, but as well to important segments of American business through its suggestion of ways and means for the lessening of specific reporting burdens. To mention but a single

instance, the suggestions of the Committee for drastically shortening and simplifying the widely burdensome financial reporting forms of the Office of Price Administration, Schedules A and B, were accepted almost intact by the Bureau of the Budget and in turn by OPA itself.

A step of special interest was an arrangement proposed by the Committee through which the War Production Board appointed a special officer known as "Industry Advocate." While the holder of this office, Mr. J. C. Woodson, is on the Government's payroll, his duties are to serve as a representative of the Committee and through it of American business in the preparation of WPB questionnaires.

The Committee has established an office under a full-time Executive Secretary at 1615 H Street in the City of Washington, where it would be glad to receive your suggestions.

A final item in our program, less tangible than those of which I have spoken, concerns the spirit in which our work is conducted. We have in the Division of Statistical Standards of the Bureau of the Budget, a small but competent technical staff of about 35 professional men and women. We know we are good, but we do not assume we are good enough to know the answers to all the questions which come our way. Our chief claim to competence is that we know the most competent people to consult upon any given problem. We hold to the view that consultation, negotiation, persuasion and agreement are often more effective in the accomplishment of needed statistical improvements than are coercion and the big stick. There is probably no agency in Washington, governmental or private, which has not shared in some manner in our work. For example, 35 subcommittees of technical experts, drawn widely from the Federal services and assisted by business organizations, are now helping us to prepare a standard classified list of commodities.

I can hear you saying, All this is very well, but Government questionnaires and report forms continue to increase. This is true. I cannot offer you the hope that questionnaires will promptly diminish any more than I could offer to free you from the burden of taxes. Legitimate wartime needs for information are still increasing. But the failure of our program of control is not for this reason to be inferred.

The control office in the War Production Board recently estimated that 25 to 30 per cent of the forms originated in the various units of that organization were internally disapproved. In the first quarter of

1943 nearly 15 per cent of the forms which came to the Bureau of the Budget for final approval were disapproved. A much larger proportion of the remainder were reworked or materially modified before our approval. Beyond this, a very large but indefinite number were still-born, aborted, or remained a mere gleam in the eye of their would-be progenitors as a result of our moral influence. But still the increase in forms which reach you continues and our current intake is at a rate of more than 5,000 forms per annum. We are rowing against a strong current and the strength of our oars and our arms cannot fairly be measured against fixed points on the shore. I am permitted to hope that the high point in the flood will soon be reached.

I solicit your understanding of our task and your participation in it, whether through the activities of the Advisory Committee, through referral to us of

reporting requests or requirements lacking approval numbers, through direct suggestions, or in any other manner which occasion or circumstance may determine. We are public servants and we regard you not only as stockholders in the enterprise which employs us, but in a peculiar sense also as our clients.

In particular I believe that you and we together, should try to develop a clearer understanding of the limits of usefulness served by statistical data in practical situations. Most decisions of everyday life, in whatever field of activity, are based upon common knowledge and practical judgment. The need to determine "cut-off points" in the collection of data which purport to supply the basis for decision and action appears in private enterprise as well as in Government. Your opinions as to where these cut-off points should be established in connection with the wartime Administration of the Federal Government would be most welcome.

Federal Postwar Public Works Totals Nearly Eight Billions

FEDERAL public works projects that might be available for postwar construction totalled \$7,695,369,000 at the turn of the year according to the annual report of the National Resources Planning Board, which was released to the public recently.

This figure includes unfinished portions of projects halted by the War Production Board, projects authorized by Congress, projects that have been recommended by various federal agencies, and projects that are receiving preliminary study. The total does not include municipal and state projects eligible for federal-aid participation.

For some years now, NRPB has been charged by the President with the annual preparation of an advance program of public work covering the next six years. Projects are supposed to be collected from the various federal construction agencies, and duplication is eliminated by the board.

Projects listed by type

War conditions made such a job impracticable this year, and the Board has instead assembled projects held in abeyance by federal agencies until after the war. In the table on the following page is listed the totals obtained in each category, according to the various types of projects.

Few of the projects, even of those which are authorized, have plans and surveys in such shape as to permit them to get going quickly. It is estimated by NRPB that less than a billion dollars worth of these projects are in shape to permit prompt action. Another measure of the immediate postwar value of the listed projects is the extent to which they include work that can be done "by the yard"—started quickly and stopped without destroying the value of work already done. About two billion fall in this category.

There is wide variation among the federal agencies as to the extent to which they are getting projects into shape. The Army Corps of Engineers, for instance, has a \$2,000,000 appropriation for advance planning this year, and a similar amount is included in its pending civil functions appropriation. If this goes through, they will have nearly all their authorized flood control projects on a ready-to-go-basis by the end of 1944 fiscal year.

On the other hand, the Forest Service, which has a \$140,000,000 forest trails program under contemplation, has authorizations for only \$2,500,000, and thus is debarred from much advance planning. Similarly, the CAA's 3,100-airport postwar program, amounting to some \$310,000,000, has not been authorized and therefore sites have not even been selected.

**Program of Post-War Construction and Improvement Works of the Federal Construction Agencies—
January 1, 1943**

Purpose classification	Estimated cost authorized projects or those requiring only Presidential authorization to undertake ¹	Estimated cost of projects requiring future congressional authorization	Tentative estimated cost of projects involved in surveys now under way or authorized	Total estimated cost of all projects
LAND DEVELOPMENT AND PROTECTION				
Flood control	\$666,820,283	\$832,216,379	\$500,000,000	\$1,999,036,662
Irrigation and reclamation	1,087,535,182		500,000,000	1,587,535,182
Forest development	73,702,420	152,537,493		226,239,913
Park development	55,852,111			55,852,111
Range land development	128,419,807			128,419,807
Wildlife development	9,405,250			9,405,250
Soil conservation	6,308,249	131,000		6,439,249
Total, land development and protection	2,028,043,302	984,884,872	1,000,000,000	4,012,928,174
PROMOTION OF TRANSPORTATION				
Rivers and harbors	221,949,340	675,519,346	150,000,000	1,047,468,686
Aids and assistance to navigation	44,247,147			44,247,147
Airports and airways	33,422,000	311,717,812		345,139,812
Roads	82,771,895	472,139,733		554,911,628
Railroads	648,167			648,167
Total, promotion of transportation	383,038,549	1,459,376,891	150,000,000	1,992,415,440
POWER GENERATION AND DISTRIBUTION²				
Dams and power plants	106,402,000	605,311,000	200,000,000	911,713,000
Transmission lines	128,297,000	66,460,000		194,757,000
Total, power generation and distribution	234,699,000	671,771,000	200,000,000	1,106,470,000
EDUCATION				
Total, education	4,931,804	13,538,362		18,470,166
WELFARE AND HEALTH				
Welfare	38,579,401	62,424,000		101,003,401
Health	25,382,500	15,820,970		41,203,470
Penal and correctional	30,100,260			30,100,260
Total, welfare and health	94,062,161	78,244,970		172,307,131
SANITATION AND WATER SUPPLY				
Total, sanitation and water supply	14,443,400	10,068,915		24,512,315
GOVERNMENT ADMINISTRATION				
Office buildings	156,690,000	7,265,000		163,955,000
Post offices and courthouses	37,500,000	131,948,000		169,448,000
Facilities for law enforcement	1,086,000	13,041,000		14,127,000
Research facilities	12,167,700	8,568,280		20,735,980
Total, Government administration	207,443,700	160,822,280		368,265,980
Total, all purposes	2,966,661,916	3,378,707,290	1,350,000,000	7,695,369,206

¹ Includes additional cost required after fiscal year 1944 to complete projects for which expenditures will be made in fiscal year 1944; also new projects available for construction; also includes cost to complete projects partly constructed but now deferred because of the war.

² This estimate excludes hydroelectric power projects included in other purpose classifications.

Highlights of ARBA Meeting in Chicago

ROADS are a major key to American victory and post-war prosperity, in the opinion of highway authorities who addressed the annual meeting and post-war conference of the American Road Builders' Association in Chicago, May 4-7.

Major General Philip B. Fleming, administrator, Federal Works Agency told delegates that plans should be made now for an overall national program of public works to stimulate employment in the post-war period. "Otherwise we are likely to go through the same old wasteful cycle of doles, made-work and relief projects," he explained. "I think the time for merely speculative post-war planning has passed. The time for designing is here. Our primary present task is to attend to the preliminaries—the legal and financial phases of public construction, the acquisition of sites and the advance engineering—so employment will be immediately available when the war ends."

Utah Congressman J. W. Robinson, chairman, House Roads Committee, advocated a backlog of highway projects that will total \$3,000,000,000 a year for at least five years after the war, as the best guarantee of post-war prosperity. "Even before the war forced a virtual moratorium on all nonmilitary construction, the nation's highway system was in grave need of improvement. A large portion of the main highways are literally horse-and-buggy roads. The only problem is that of getting these projects under way. The magnitude of this task is so great that it can only succeed through the participation of all road-building agencies. Every state, county and city must have a planned program of highway construction. Reserve funds should be accumulated now to finance post-war projects or to participate with the federal government on a matching or loan-and-grant basis.

Visions of a nation interlaced with superspeed highways were drawn by West Virginia Congressman Jennings Randolph at the President's Dinner, entertainment highlight of the conclave. He predicted a giant post-war highway, airport and flight-strip program. Describing a bill now pending in Congress to provide for six superhighways, he said they would be links in transcontinental routes from New England to Florida, Florida to California and San Francisco to New England.

Rural roads in the post-war program were dis-

cussed by Nebraska Congressman Karl Stefan. He explained the close relationship between farm-to-market road conditions and the prosperity of the farmer, as well as the well being of everyone with whom he does business. Speaking at a County Division meeting, Wiley M. Riedel, president, National Rural Letter Carriers Association, quoted letters from his members pointing out the increased cost of mail delivery as a result of road deficiencies.

Colonel Willard T. Chevalier, publisher, *Business Week*, addressed the luncheon-meeting of the Post-War Highway Program Committee. He told delegates that post-war planning should not be based on the expectation of a depression after the war but upon the serious need for highway improvement. Colonel Chevalier also acted as moderator for the Post-War Forum. On the panel were Congressmen Jesse P. Wolcott of Michigan and James W. Mott of Oregon, Ohio Highway Director Hal G. Sours, Tracy Harron, past president, Associated Equipment Distributors; Manufacturers' Division President E. R. Galvin, Contractors' Division President James J. Skelly, Municipal Division President Raleigh W. Gamble and Manton Hannah, McLennan county engineer, Waco, Tex., who represented the County Highway Officials' Division as its immediate past president.

Relief of unemployment through post-war road construction was stressed by Missouri Chief Engineer Carl W. Brown, newly elected ARBA president. New division presidents installed at this meeting were James J. Skelly, president, Associated Pennsylvania Constructors, Media, Contractors; R. B. Traver, Onondaga county superintendent of highways, Syracuse, N. Y., County, and E. R. Galvin, general sales manager, R. G. Le Tourneau, Inc., Peoria, Ill., Manufacturers.

W. P. Witherow, president, Blaw-Knox Co., took up the problem of reconversion to peace from the manufacturers' point of view. City planning and financing were analyzed by Robert Moses, member, New York City Planning Commission, and Major I. V. A. Huie, New York City commissioner of public works. Road construction in urban areas was also featured by Frank Herring, assistant director, National Resources Planning Board. H. O. Penn, AED vice-president and president, Penn Machinery Co., presented the viewpoint of the equipment distributor.

MANUFACTURERS' DIVISION

of the

NATIONAL CRUSHED STONE ASSOCIATION

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

Allis-Chalmers Mfg. Co.

Milwaukee, Wis.
Crushing, Screening, Washing, Grinding,
Cement Machinery; Motors; Texrope
Drives; Centrifugal Pumps; Tractors

American Cyanamid & Chemical Corp.

Explosives Department
30 Rockefeller Plaza, New York, N. Y.
Explosives and Blasting Supplies

**American Manganese Steel Division of
American Brake Shoe Company**

389 East 14th St., Chicago Heights, Ill.
Manganese Steel Castings, Power Shovel
Dippers, Material Handling Pumps, Heat
and Corrosion Resistant Castings, Recla-
mation and Hard-Facing Welding Ma-
terials

The American Pulverizer Co.

1249 Macklind Ave., St. Louis, Mo.
Manufacturers of Ring Crushers and Ham-
mermills for Primary and Secondary
Crushing

Atlas Powder Co.

Wilmington, Del.
Industrial Explosives and Blasting Supplies

Auto Ordnance Corporation.

Nostrip Division

80 Broadway, New York, N. Y.
Nostrip, Rostreet

Earle C. Bacon, Inc.

17 John St., New York City
Primary and Secondary Crushers, Rolls,
Screens, Elevators, Conveyors—Complete
Plants designed and equipped

Barber-Greene Company

Aurora, Illinois
Portable and Permanent Belt Conveyors,
Belt Conveyor, Idlers, Bucket Loaders
both Wheel and Crawler Mounted, As-
phalt Mixers and Finishers, Coal Hand-
ling Machines

Brooks Equipment and Mfg. Co.

408-10 Davenport Road, Knoxville, Tenn.
"Brooks Load Luger" (Stone Hauling
Equipment). DAY Jaw Type Rock Crush-
ers. DAY Pulverizers, or "Swing Ham-
mer" Crushers

**C. G. Buchanan Crushing Machinery Divi-
sion of the Birdsboro Steel Foundry and
Machine Co.**

90 West Street, New York City
Primary, Secondary and Finishing Crushers
and Rolls

Bucyrus-Erie Co.

South Milwaukee, Wis.
Excavating, Drilling and Material Handling
Equipment

Cross Engineering Co.

Carbondale, Pa.
Screen Plates and Sections, Perforated Plate,
for Vibrating, Rotary and Shaking Screens

Deister Machine Company

1933 East Wayne Street, Fort Wayne, Ind.
Deister Plat-O Vibrating Screen, Deister
Compound Funnel Classifier

Diamond Iron Works, Inc.

Minneapolis, Minn.
Rock Crushing, Conveying and Transmis-
sion Machinery

E. I. du Pont de Nemours & Co., Inc.

Wilmington, Del.
Explosives and Blasting Accessories

Dymonhard Corporation of America

250 West 57th St., New York City
Hard Facing Welding Rods

Easton Car and Construction Co.

Easton, Pa.
Quarry Cars, Truck Bodies and Trailers
Electric Heaters for Tar, Asphalt or Bitumen

Ensign-Bickford Co.

Simsbury, Conn.
Cordeau-Bickford Detonating Fuse and
Safety Fuse

MANUFACTURERS' DIVISION of the NATIONAL CRUSHED STONE ASSOCIATION

Frog, Switch & Mfg. Co.

Carlisle, Pa.

Manganese Steel Department—Manufacturers of "Indian Brand" Manganese Steel Castings for Frogs, Switches and Crossings, Jaw and Gyratory Crushers, Cement Mill, Mining Machinery, etc., Steam Shovel Parts

General Electric Co.

1 River Road, Schenectady, N. Y.

Electric Motors

Goodyear Tire & Rubber Co.

Akron, Ohio

Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous), Chute Lining (Rubber)

Gruendler Crusher and Pulverizer Co.

2915 N. Market St., St. Louis, Mo.

Rock and Gravel Crushing and Screening Plants, Jaw Crushers, Roll Crushers, Hammer Mills, Lime Pulverizers

Hayward Co.

50 Church Street, New York City

Orange Peel Buckets, Clam Shell Buckets, Drag Line Buckets, Electric Motor Buckets, Automatic Take-up Reels

Hendrick Mfg. Co.

Carbondale, Pa.

Perforated Metal Screens, Perforated Plates for Vibrating, Shaking and Revolving Screens; Elevator Buckets; Hendrick Vibrating Screens

Hercules Powder Co.

Wilmington, Del.

Explosives and Blasting Supplies

Illinois Powder Mfg. Co.

124 N. 4th St., St. Louis, Mo.

Gold Medal Explosives

Iowa Manufacturing Co.

Cedar Rapids, Iowa

Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Hot and Cold Mix Asphalt Plants, Stabilizer Plants, KUBIT Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment.

Kennedy-Van Saun Mfg. and Eng. Corp.

2 Park Ave., New York City

Material Handling Machinery—Crushers, Pulverizers, Vibrating Screens

Kensington Steel Co.

505 Kensington Ave., Chicago, Ill.

Manganese Steel Castings, Dipper Teeth, Crawler Treads, Jaw Plates, Concaves and Hammers

Keystone Driller Co.

Beaver Falls, Pa.

Drills, Power Shovels

The King Powder Co., Inc.

Cincinnati, Ohio

Detonite, Dynamites, and Blasting Supplies

Koehring Co.

3026 W. Concordia Ave., Milwaukee, Wis.

Mixers, Pavers, Shovels, Cranes, Draglines, Dumpers, Traildumps, Mud-Jacks

Kotal Company

52 Vanderbilt Ave., New York City

KOTAL, the Waterproofing Agent for Aggregates that Improves Hot Mixes, Cold Mixes, Traveling Plant Mixes and Road Mixes of Bitumen

Lima Locomotive Works, Inc.

Shovel and Crane Division

1108 Lima Trust Bldg., Lima, Ohio

Power Shovels, Draglines and Cranes

Link-Belt Co.

300 West Pershing Road, Chicago, Ill.

Complete Stone Preparation Plants. Conveyors, Elevators, Screens, Washing Equipment, Speed-o-Matic Shovels—Cranes—Draglines and Power Transmission Equipment

Ludlow-Saylor Wire Co.

Newstead Ave. & Wabash R. R., St. Louis, Mo.

Woven Wire Screens and Wire Cloth of Super-Loy, Manga-Loy and all commercial alloys and metals

Mack Manufacturing Corp.

34st St. & 48th Ave., Long Island City, N. Y.

Trucks, Truck-Tractors of All Types and Capacity, Gasoline or Diesel Power Optional

MANUFACTURERS' DIVISION of the NATIONAL CRUSHED STONE ASSOCIATION

Marion Steam Shovel Co.

Marion, Ohio
*A Complete Line of Power Shovels, Drag-
lines and Cranes*

McLanahan & Stone Corp.

Hollidaysburg, Pa.

The National Supply Co., Superior Engine Division

1401 Sheridan Ave., Springfield, Ohio
Diesel Engine Equipment

Nordberg Mfg. Co.

Milwaukee, Wis.
*Cone Crushers, Vibrating Screens, Diesel
Engines, Steam Engines, Compressors,
Mine Hoists, Underground Shovels, Track
Maintenance Tools*

Northern Blower Co.

65th St. South of Denison, Cleveland, Ohio
*Dust Collecting Systems, Fans—Exhaust
and Blowers*

Northwest Engineering Co.

28 E. Jackson Blvd., Chicago, Ill.
Shovels, Cranes, Draglines, Pullshovels

Parsons Engineering Corp.

3599 E. 82d St., Cleveland, Ohio
*Dust Collecting Systems: Fans, Hoods and
Blow Piping*

Pioneer Engineering Works, Inc.

1515 Central Avenue, Minneapolis, Minn.
*Jaw and Roll Crushers, Vibrating and Re-
volving Screens, Scrubbers, Belt Convey-
ors, Traveling Grizzly Feeder*

Pit and Quarry Publications

538 South Clark St., Chicago, Ill.
*Pit and Quarry, Pit and Quarry Handbook,
Pit and Quarry Directory, Concrete Manu-
facturer, Concrete Industries Yearbook*

Robins Conveying Belt Co.

Passaic, N. J.
*Belt Conveyors, Bucket Elevators, Gyrex
and Vibrex Screens, Feeders, Design and
Construction of Complete Plants*

Rock Products

309 West Jackson Blvd., Chicago, Ill.

Ross Screen and Feeder Co.

19 Rector St., New York City
*Ross Patent Chain Feeders for Feed Control
of All Sizes Rock, Ores, Gravel, etc.*

Screen Equipment Co.

9 Lafayette Ave., Buffalo, N. Y.
SECO Vibrating Screens

Simplicity Engineering Co.

Durand, Mich.
*Simplicity Gyrating Screen, Simplicity
D'centegrator, Simplicity D'watering
Wheel*

Smith Engineering Works

E. Capitol Drive at N. Holton Ave.,
Milwaukee, Wis.
*Gyratory, Gyrasphere, Jaw and Roll Crush-
ers, Vibrating and Rotary Screens, Gravel
Washing and Sand Settling Equipment,
Elevators and Conveyors, Feeders, Bin
Gates, and Portable Crushing and Screen-
ing Plants*

Stedman's Foundry & Machine Works

Aurora, Indiana
*Stedman Impact-Type Selective Reduction
Crushers*

Taylor-Wharton Iron & Steel Co.

High Bridge, N. J.
*Manganese and other Special Alloy Steel
Castings*

The Texas Co.

135 E. 42nd St., New York City
Asphalts, Lubricating and Fuel Oils

The Thew Shovel Co.

Lorain, Ohio
*Power Shovels, Cranes, Crawler Cranes,
Locomotive Cranes, Draglines. Diesel
Electric, Gasoline. 3/8 to 2-1/2 cu. yd.
capacities*

The Traylor Engineering & Mfg. Co.

Allentown, Pa.
*Stone Crushing, Gravel, Lime and Cement
Machinery*

Trojan Powder Co.

17 N. 7th St., Allentown, Pa.
Explosives and Blasting Supplies

The W. S. Tyler Co.

3615 Superior Ave., N. E., Cleveland, Ohio
*Wire Screens, Screening Machinery, Scrub-
bers, Testing Sieves and Dryers*